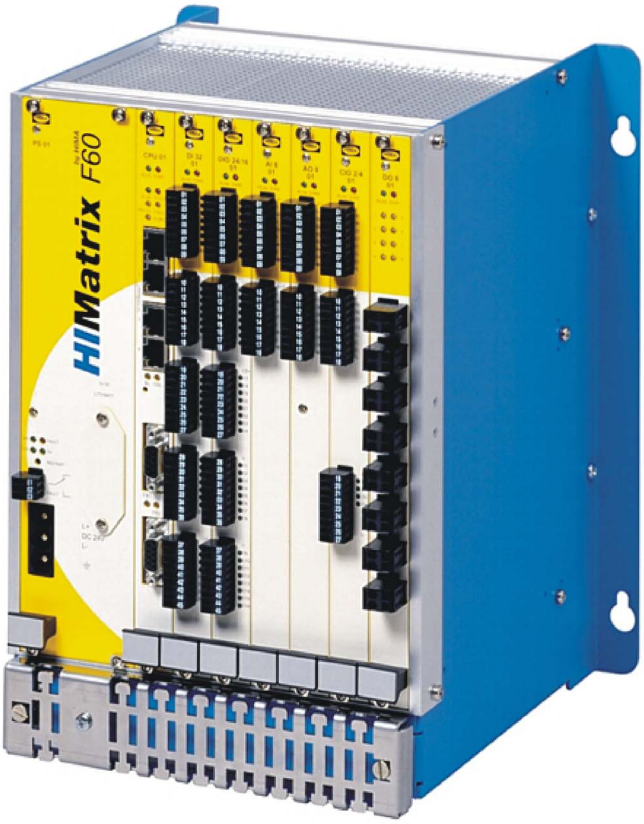
Industrial-Automation

System *HIMatrix F60*

Modular System F60

System Manual



HIMA Paul Hildebrandt GmbH + Co KG
Industrial Automation

HI 800 191 FEA

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For more information see the documentation on CD-ROM and on our web site www.hima.com .

More information can be requested from:

HIMA Paul Hildebrandt GmbH + Co KG
Postfach 1261
68777 Brühl

Tel: +49(6202)709 0
Fax: +49(6202)709 107

e-mail: info@hima.com

About this Manual

The F60 safety-related HIMatrix modular system as described in this manual can be used for several different purposes. Persons responsible must ensure that all necessary steps have been considered to fulfill the safety requirements and conditions for these applications, including compliance with valid standards, rules and applicable legislation.

In case of unqualified interventions into the automation devices, de-activating or bypassing safety functions, or if advices of this manual are neglected (causing disturbances or impairments of safety functions), severe personal injuries, property or environmental damage may occur for which HIMA cannot take liability.

HIMatrix Automation Devices are developed, manufactured and tested according to the relevant safety standards. They must only be used for the applications described in the instructions and with specified environmental conditions, and only in connection with approved external devices.

Intended Readership

This manual is intended for project engineers, programmers and maintenance staff with general knowledge in the area of automation devices.

P. O. Box 1261
D - 68777 Bruehl near Mannheim

Phone +49 6202 709-0

Fax +49 6202 709-107

E-mail info@hima.com

Internet http://www.hima.com

Further System Documentation

For engineering the HIMatrix systems there are available the following documents:

Name	Contents	Document No. D = german E = english	Part No.
HIMatrix Safety Manual*	Safety functions of HIMatrix systems	HI 800 022 (D) HI 800 023 (E)	pdf file
HIMatrix System Manual Compact Systems	Documentation of the hardware of compact systems with technical data	HI 800 140 (D) HI 800 141 (E)	pdf file
HIMatrix Engineering Manual	Planning and construction of HIMatrix systems	HI 800 100 (D) HI 800 101 (E)	pdf file
HIMatrix Manual First Steps	Introduction to ***ELOP II Factory***	HI 800 005 (D) HI 800 006 (E)	96 9000013 96 9000014 pdf file

* Shipping only with HIMatrix systems

Terminology

Term	Definition
AI	Analog Input
AIO	Analog Input/Output
AO	Analog Output
COM	Communication Module
CPU	Central Processing Unit
DI	Digital Input
DIO	Digital Input/Output
DO	Digital Output
EMC	Electromagnetic Compatibility
FB	Field Bus
FBD	Function Block Diagram
FTZ	Fault Tolerance Time
IEC	International Electrotechnical Commission
MEZ	Multiple fault occurrence time
OLE	Object Linking and Embedding
OPC	OLE for Process Control
PADT (PC)	Programming and Debugging Tool (according IEC 61131-3)
PES	Programmable Electronic System
R	Read
R/W	Read/Write
SFC	Sequential Function Chart
SIL	Safety Integrity Level (according to IEC 61508)
SNTP	Simple Network Time Protocol (RFC 1769)
TMO	Timeout
W	Write
WD	Watchdog

Contents

1 Certification

The safety-related HIMA HIMatrix programmable controllers (Programmable Electronic Systems, PES) are tested and certified by TÜV for functional safety in accordance to CE and the standards listed below:

TÜV Anlagentechnik GmbH
Automation, software and information technology
Am Grauen Stein
51105 Köln

Certificate and test report No. 968/EZ 128.08/05
Safety-related automation devices
HIMatrix F60, F35, F31, F30, F3 DIO 20/8 01, RIO-NC

Certificate and test report No. 968/EZ 181.01/05
Safety-related automation devices
HIMatrix F20

International standards:

IEC 61508, part 1-7: 2000

IEC 61511: 2004

EN 954-1: 1996

EN 12067-2: 2004, EN 298: 2003, EN 230: 1990

NFPA 85: 2001

EN 61131-2: 2003

EN 61000-6-2: 2001, EN 61000-6-4: 2001

F 60 and F35: EN 54-2: 1997, NFPA 72: 2002

National standards:

DIN VDE 0116: 1989, EN 50156-1:2004

Chapter **12 Operating conditions** contains a detailed listing of all applied environment and EMC tests.

All devices are labeled with the CE sign.

2 Notes for Danger and Use

This manual contains specially highlighted advices that indicate safety requirements:

2.1 Notes for Danger

Important information regarding situations or operations. Failure to observe these instructions could cause personal injury and/or damage to property.

These notes

- indicate danger,
- help you avoid danger,
- make you aware of the consequences.

2.2 Notes for Use

Note Special instructions to aid understanding and correct use.

These instructions will help you to operate the controller correctly and will provide you with better understanding of the system.

3 Assembly

3.1 General Information

In order to ensure a fault-free operation, the operating conditions (cf. chapter 12) must be observed when to decide where to install the F60.

Notes

- For effective cooling, the device must be fitted on a horizontal standard rail.
- There must be a gap of at least 100 mm above and below the device.
- The device may not be fitted above heating equipment or any source of heat.

For the assembly of the devices and the attention of the maximum operating temperature the descriptions in the **HIMatrix Engineering Manual** are to be considered.

3.2 Installing onto a Base

The F60 has two vertical plates, each with two oblong holes to secure the unit. It must be secured to a flat, even base.

When installing the F60 make sure that it is fastened in place with no mechanical distortion.

The installation screws should not be more than 6 mm in diameter, and the diameter of the head of the screws no more than 13 mm. The screws and the selected fixing sub-base must be able to bear the weight of the controller.

Securing the plate

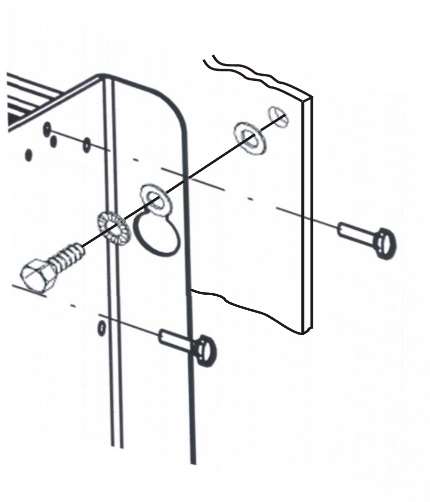

Figure 1: F60 Installing onto a base

The controller is assembled without connecting the terminals. Only personnel who have knowledge of ESD protective measures are permitted to carry out system modifications and replace modules.

An electrostatic discharge can damage the built-in electronic components.

- Touch an earthed object to discharge any static about your person.
- When carrying out the work, make sure the working area is free of static and wear an earthing strip.
- When the F60 and the modules are not in use, ensure they are protected from electrostatic charges, e.g. keep it in its packaging.

3.3 Monitoring the Temperature State

The CPU 01 central module monitors the temperature state (operating temperature) of the HIMatrix F60.

The CPU evaluates the temperature states of the single modules including the power supply and the CPU itself.

The temperature state of the particular module is measured by one temperature sensor in a relevant temperature location. This sensor monitors automatically and continuously the temperature state of the device. The status messages for the various temperature thresholds of the temperature state come from one of these sensors dependent on the heating of the modules.

The HIMatrix F60 has two fans behind the earthing grid, which are controlled by the CPU module dependent on the temperature state:

Temperature state	Fan state
< 50 °C	Normal (both fans ON)
> 50 °C	Both fans in full operation

Table 1: Monitoring the fan state

The fan states can be evaluated on a programming unit running the software ***ELOP II Factory*** via the ***Fan State*** (see chapter 7.4.1) system signal.

The temperature state signals the measured temperatures in the following temperature ranges:

Temperature state	Temperature range	Signal value [BYTE] ***Temperature State***
< 60 °C	Normal	0x00
60 °C to 70 °C	High temperature	0x01
> 70 °C	Very high temperature	0x03
Return to 64 °C to 54 °C	High temperature	0x01
Return to < 54 °C	Normal	0x00

Table 2: Monitoring the temperature state

If the temperature at one temperature sensor of a module rises above a temperature threshold, the temperature state changes.

The temperature states can be evaluated using the ***Temperature State*** system signal (see chapter 7.4.1) on a programming unit running ***ELOP II Factory***.

The differing temperature ranges at decreasing temperature compared to increasing temperatures are caused by the hysteresis of the temperature sensor. The hysteresis is about 6 °C. Therefore the threshold for the range of "High temperature" is shifted by this amount at decreasing temperatures.

Note In case of lacking or insufficient circulation and inadequate natural convection within a cabinet the threshold to the range "High temperature" of the HIMatrix F60 can already response at ambient temperatures (within the cabinet) of 35 °C.

Reason: local overheating, insufficient heat dissipation by constricted convection.

3.4 Electrical Connections

Only personnel who have the knowledge of EMC protective measures are permitted to carry out system modifications/upgrades to the system wiring.

An electrostatic discharge can damage the built-in electronic components.

- Touch an earthed object to discharge any static in your body.
- When carrying out the work, make sure to use an ESD protected working area and wear an earthing strip.
- When the module is not in use, ensure it is protected from electrostatic discharges, e. g. keep it in its packaging.

3.4.1 Deenergize to Trip Mode / Energize to Trip Mode

The programmable controllers are designed for the deenergize to trip mode.

The HIMatrix systems are certified for process controllers, safety systems, burner systems and machine controllers.

A system operating according to the deenergize to trip mode does not need energy to perform its safety function.

In the event of a fault, the input and output signals revert to voltage-free or current-free states to ensure safe operation.

The HIMatrix controllers can also be used in energize to trip mode applications.

A system operating according to the energize to trip mode needs energy, for example electrical or pneumatic energy, to perform its safety function.

Therefore the HIMatrix F60, F35 and F3 AIO 8/4 01 were tested and certified according to EN54 and NFPA72 for use in fire alarm systems and fire extinguish systems. In these systems it is necessary that on demand the active state is used for controlling the danger (further details see **Engineering Manual**).

3.4.2 Earthing

On the front left of the earthing grid at the bottom is an earthing screw, which is marked with the earthing symbol.

Note
- To improve EMC conditions, the housing must be grounded.
- The connection to the next grounding point must be as short as possible to create a small earthing resistance.

The F60 controller can be operated either with an earthed L- reference pole or unearthed. If operating in an unearthed state, earth-fault monitoring must be carried out (e.g. see VDE 0116).

3.4.3 Connecting the Operating Voltage

The electrical connection is carried out via the 3-pole withdrawable connector on the front plate of the power supply module. The connector can accommodate lines of 6 mm².

Connection	Function
L+ DC 24 V	Voltage supply L+ (24 VDC)
L- DC 24 V	Voltage supply L- (24 VDC, reference pole)
⏚	Earthing / shielding

Table 3: Connecting the operating voltage

If a shielded line is used for the voltage supply, the shield is also connected via the earthing contact to the connector of the voltage supply.

The power supply must fulfill the requirements of IEC/EN 61131-2 or SELV (Safety Extra Low Voltage) or PELV (Protective Extra Low Voltage).

3.4.4 Monitoring the Operating Voltage

During operation the 24 VDC is automatically monitored; reactions are dependent on the voltage levels shown below:

Voltage level	Reaction of the controller
19.3 V to 28.8 V	Normal operation, no reaction
< 18.0 V	Alarm state (internal variables are written and put to the inputs/outputs)
< 12.0 V	Disconnection

Table 4: Monitoring the operating voltage

The operating voltage can be evaluated on a programming unit running the software ***ELOP II Factory*** via the ***Power Supply State*** system signal (see chapter 7.4.1).

3.4.5 Securing the Cable and Connecting the Shielding

The cables are fed in vertically from below and secured with two cable binders onto the reeds of the earthing grid.

The shielding of a cable (if present) is attached to the earthing grid with a bracket. The bracket is also positioned over the not insulated cable shielding and is pushed into the oblong holes of the earthing grid on both sides until it fits firmly in place.

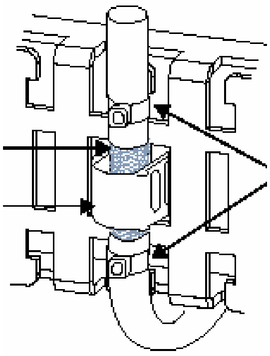

Figure 2: Securing the cable and connecting the shielding

The shield clamp may not be used as a strain relief for the connected cable.

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4 Modules

4.1 General

All PES HIMatrix F60 modules are 6 units high, corresponding to 262 mm.

Specific slots are only provided for the power supply and central modules (see section 4.2 "Equipment of the PES"). All other slots can be fitted with modules of various functions (depending on their use).

Note The order of the module assembly must correspond to the assignment in the application program.

The way in which the PES is assembled can only be changed if the unit is switched off, i.e. the system is not in operation.

The relevant modified application program must then be re-loaded.

Note Modules may not be removed or inserted during operation!

The I/O circuits are connected onto the front plates of the modules using pluggable terminals. The status of the digital signals is indicated via LEDs next to the terminals.

4.1.1 Inputs

The input channels of the modules are used to transfer and to match signals between the production plant and the microprocessor systems on the central module.

The safety-related modules are continuously tested. Regardless of the error, only the affected channel or the whole module is switched off and displayed as defective; the logic of the application program then receives safe 0-signals as input signals from the operating system of the controller.

Signal sources with their own dedicated power supply can also be connected instead of contacts. The reference pole of the signal source must then be connected to the reference pole of the input.

4.1.1.1 Surge on Digital Inputs

In the case of digital inputs, an EN 61000-4-5 surge impulse can be read as a short-time H-signal (caused by the short cycle time of the HIMatrix system).

To avoid errors in these cases, one of the following measures must be taken in respect to the applications:

- Installation of shielded input lines to prevent the effects of surges in the system,
- Fault masking in the application program: A signal must be present at least twice before it is evaluated.

Attention: This extends the reaction time of the system!

The mentioned measures can be neglected if surges in the system can be excluded by the construction of the plant. The construction includes especially protection measures concerning overvoltage, lightning strike, earthing and wiring on base of manufacturers instructions and relevant standards.

4.1.1.2 Line Control

Line Control is a short-circuit and line break monitoring system, for example, of EMERGENCY STOP inputs (cat. 4 according to EN 954-1), which can be configured on the F60 system.

In addition, the digital outputs DO 1 to DO 8 of module DIO 24/16 01 are connected to the DI digital inputs of the same (or different) module, as shown below (example):

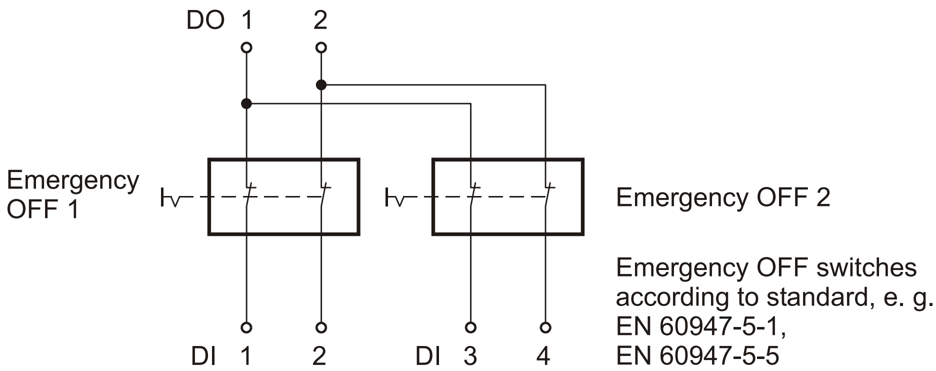

Figure 3: Line Control

The digital outputs DO 1 to DO 8 are pulsed and in this way the lines to the digital inputs of module DI 32 01 or DIO 24/16 01 are monitored.

The LED “ERR” on the module front plate flashes, the inputs are set to 0-signal and an error code (which can be evaluated) is generated when the following errors occur:

- Short-circuit between two parallel lines,
- Change of two lines (e.g. DO 2 to DI 3),
- Earth fault on one of the lines (only with earthed reference pole),
- Line break or opening of the contacts, i.e. when one of the Emergency OFF switches (displayed above) is pressed, the LED “ERR” also flashes and the error code is generated.

How to configure Line Control in the application program is described in the **HIMatrix Engineering Manual**.

4.1.2 Outputs

The output channels of the modules are used to transfer and to match signals between the microprocessor systems on the central module and the production plant.

The modules are continuously tested. Regardless of the error, only the affected channel or the whole module is switched off and displayed as defective; the outputs go into a safe, power-free state.

The terminals for output circuits may not be plugged with load connected. With existing short-circuits the resulting high current may damage the terminals.

Inductive loads can be connected without a protection diode on the load. We strongly recommend that a protection diode is fitted directly to the load to suppress any interference voltage.

4.1.2.1 Line Control

The digital outputs DO 1 to DO 8 of the module DIO 24/16 01 can be used for short-circuit or line break monitoring of the digital inputs of the module DI 32 01 or DIO 24/16 01, for example, with EMERGENCY STOP buttons conform to Cat. 4 as specified in EN 954-1. The outputs are pulsed and connected to the safety-related inputs (see section 4.1.1.2). In this case the outputs have the function of pulsed outputs.

A module with relay contact outputs, e.g. DO 8 01, cannot be used for this purpose.

Pulsed outputs must not be used as safety-related outputs!

4.2 Equipment of the PES

A modular spacing unit (SU) has a width of 5.08 mm (0.2 inch). There is a total of 40 SU available, 24 of which can be used with any of the input and output modules as required.

Assembly (from left to right)

- first slot **only** for power supply module PS 01
- next slot **only** for central module CPU 01
- I/O slots numbered from 1 to 6,
  I/O modules with various functions can be inserted as required

The following table shows a list of modules, which are available at present:

Designation	Central functions	Width
PS 01	Power supply module	12 SU
CPU 01	Central module with communication	4 SU
Designation	**Central functions**	**Width**
AI 8 01	8 analog inputs	4 SU
AO 8 01	8 analog outputs	4 SU
CIO 2/4 01	2 counters, 4 digital outputs	4 SU
DI 24 01	24 digital inputs (110 VDC)	4 SU
DI 32 01	32 digital inputs	4 SU
DIO 24/16 01	24 digital inputs, 16 digital outputs	4 SU
DO 8 01	8 relay outputs (up to 230 VAC / 110 VDC)	4 SU
MI 24 01	24 inputs analog or digital	4 SU

Table 5: Equipment of the PES

4.3 Using Modules

The modules are assembled without the terminal connections of the connecting cable being plugged in.

Personnel must also be protected from electrostatic.

⚠ **An electrostatic discharge can damage the built-in electronic components of a module.**

- Touch an earthed object to discharge any static in your body.
- When carrying out the work, make sure the working area is free of static and wear an earthing strip.
- When the modules are not in use, make sure they are protected from electrostatic charges, e.g. keep them in their packaging.

Inserting modules

- Push the modules – without tilting them – as far as they will go into both guide supports, which are located at the top and bottom in the housing.
- Push the upper and lower ends of the front plate until the connector of the module is firmly in place in the socket of the backplane.
- Secure the module with both screws on the upper and lower ends of the front plate.

Removing modules

- Remove all connectors from the front plate.
- Loosen both securing screws on the upper and lower ends of the module front plate.
- Using the grip (located at the bottom on the front plate), loosen the module and pull it out of the guide supports.

4.4 Reset Pushbutton

The CPU of the control is equipped with a reset pushbutton. An operating of the reset will be necessary e.g. if the password for connecting a PADT is forgotten.

The pushbutton is accessible through a small round hole on the front plate of the CPU module. The activation must be made with a suitable pin of insulating material to prevent short-circuits inside the module.

The reset is only effective when the control is booted anew and simultaneously the pushbutton is pressed for at least 20 seconds. An activation during operation of the device has no influence.

Note During a reset the field bus interface may not be connected to a field bus in operation, as this will result in malfunctions there.

With activation of the reset pushbutton

- IP address and system ID (SRS) are set to default values,
- all accounts are deactivated (except default account "Administrator" without password).

Note After activation of the reset pushbutton the values are modified until a new reboot, then the previous information are valid again! After a reset the user must enter new information if necessary.

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5 Maintenance and Repairs

Note For safety-related use the module must be generally overhauled in periodical time intervals (see **Safety Manual**).

The fans of the controller and the back-up battery in the power supply module have to be replaced at specified intervals.

Personnel must discharge electrostatic from about their body before touching supply or signal lines.

Only personnel who have knowledge of EMC protective measures are permitted to carry out modifications to supply/signal lines and/or upgrade with modules.

5.1 Changing the Fans

- Loosen both fixing screws (left and right) on the earthing grid.

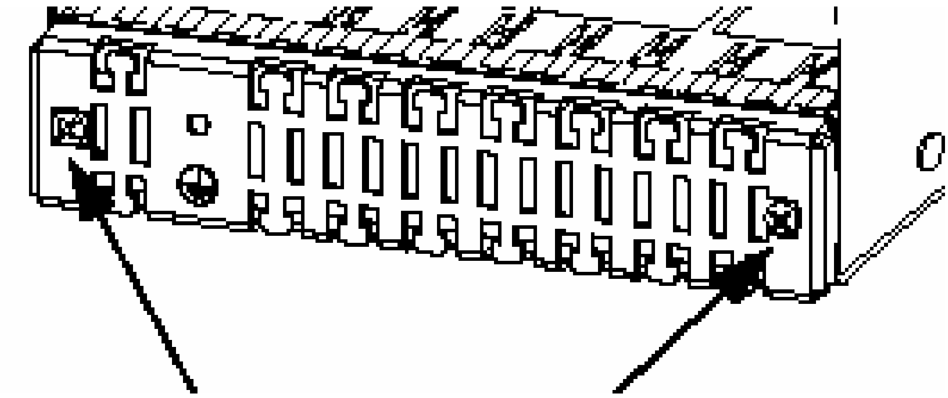


Figure 4: Earthing grid with fixing screws

- Move the earthing grid and the attached cables into a position, which allows the fan support plate (positioned behind it) to be removed.
- Loosen the connector (for the voltage supply of the fans) and pull out the fan support plate.
- Loosen the four fixing screws on each fan to be able to remove and then replace them.

Note The fans can be replaced whilst the PES is in operation.
It does not need to be switched off.

Replacing the fans

- at normal temperatures (<40 °C): every 5 years
- at higher temperatures (>40 °C): every 3 years

5.2 Changing the Back-up Battery

There is a back-up battery built into the power supply module to store data and to operate the clock in the event of the supply voltage failing.

Note	The back-up battery should be changed every four years.

More detailed information on changing the back-up battery can be found in the power supply module data sheet.

The battery can be changed while the system is running. Therefore the system ID and the IP address in the NVRAM of the CPU is stored and a new transfer into the controller is not necessary.

5.3 Faults

Faults in the central module normally cause a shutdown of the entire controller and are indicated on the CPU by the LED "ERR".

Possible causes for the display "ERR" see datasheet of the CPU 01.The display can be switched off via the command *Reboot Resource* in the menu *Extra* of the Control Panel. The controller will be rebooted and started again.

Faults in the input and output modules are automatically detected during operation and indicated on the front plate of the affected module via the LED “ERR”.

Connecting a programming unit allows errors to be diagnosed, even if the controller has stopped, providing the communication has not been affected.

Before replacing an I/O module, check whether an external line fault is present, and that the relevant sensor/actuator is functioning correctly.

Repairs of an F60 safety-related HIMatrix unit (or to one of its modules) must only be carried out by HIMA manufacturers. Any unauthorized work carried out on the module could impair the functional safety and will nullify the guarantee and the certification.

5.4 Service and Training

Contact the HIMA service department to set a date for commissioning, testing and modifying the control system and to discuss what work needs to be done.

HIMA offers software and PES hardware training courses, which normally take place at HIMA. However, training can also be provided on site at the customer.

The current training programs and dates can be obtained from HIMA, as well as offers on special external seminars.

6 Communication via the CPU

The communication section of the CPU is attached to the safe microprocessor system via a Dual-Port RAM. It controls the communication between the PES and other systems via powerful interfaces:

- 100BaseT: Safe**ethernet** / Ethernet / OPC / Programming unit (PADT), TCP-SR, SNTP, Modbus TCP
- Field buses: Profibus-DP, Modbus, Interbus

6.1 Ethernet Communication

6.1.1 Communication via Switches

The CPU of the F60 control is fitted with a 5-way switch. One of the five ports is used for the internal Ethernet communication, while the other four are for external communications via the RJ-45 connections.

- In contrast to a hub, a switch is able to store data packets for a short period of time in order to establish a temporary connection between two communication partners (transmitter/receiver) for the transfer of data. In this way, collisions (typical of a hub) can be avoided and the load on the network is reduced. For controlled data transfer every switch needs an address/port relation table. This table will be automatically generated in a self-learning process. Each port in the switch is correlated to defined MAC addresses. According to this table incoming data packages are directly switched to the correspon-ding port. For Ethernet Frame Buffering there exists a 128 kByte SRAM.
- The switch automatically switches between the transfer rates of 10 and 100 MBit/s and between full and half duplex connections. This makes the full bandwidth available (full duplex operation) in both directions.
- A switch controls the communication between different devices. The switch can address up to 1000 absolute MAC addresses.
- Autocrossing recognizes that cables with crossed wires have been connected, and the switch adjusts accordingly.

Note	When configuring the safety-related communication in accordance to the HIMatrix manual, the information contained in the Safety Manual must be regarded.

6.1.2 Safeethernet

In the field of automation central themes are requirements like determinism, reliability, changeability, enlargement and over all safety.

Safe**ethernet** provides a transfer protocol for transmitting safety-related data up to SIL 3 on base of the Ethernet technology.

Safe**ethernet** implements mechanism that can detect and react safety-related on the following faults:

- Corruptions of the transmitted data (duplicate, lost, changed bits)
- Wrong addresses of messages (transmitter, receiver)
- Wrong sequence of data (repetition, lost, change)
- Wrong timing (delay, echo)

Safe**ethernet** is based on the standard Ethernet or FastEthernet according to IEEE802.3.

The transmission of the safety-related data uses the protocol frame of the standard Ethernet.

According to the Black Channel Approach in safe**ethernet** "insecure transmission channels" (Ethernet) are used and controlled by safety-related protocol mechanism at transmitter and receiver.

In this way normal Ethernet network components like hubs, switches, routers and PCs supplied with network interfaces can be used within a safety-related network.

The significant difference to standard Ethernet is determinism, the real-time ability, of safe**ethernet**. A special protocol mechanism guarantees deterministic behavior even in case of faults or new entries of communication participants. New components are automatically integrated in the running system. All components of the network could be changed while the system is running. With the use of switches transmission times can be clearly defined. In this way Ethernet works in real-time.

The possible transfer speed up to 100 Mbit/s for safety-related data is higher then the speed normally used. For example copper lines as well as fiber optic cables can be used as transmission media.

The integration of firm intranets as well as connections to the Internet can be realized with safe**ethernet** technology. The terms for safety-related communication according to the HIMatrix Safety Manual have to be considered. Therefore only one network for safety and non-safety data transfer is necessary.

Safe**ethernet** can be fitted to existing Ethernet networks with adjustable network profiles.

With safe**ethernet** one can built-up flexible system structures for the decentral automation with defined reaction times. According to the requirements the intelligence can be centralized or distributed in a decentral way to the participants within the network. There is no limit in the number of safe participants of the network and the amount of transferred safe data to get the needed reaction times. A central controller and the built-up of parallel structures is therefore superfluous.

The transmission of safe data is integrated in the existing Ethernet network. A separate safety bus can be saved. The switches in the HIMatrix controllers overtake tasks for which normally network switches are needed.

The configuration of safe**ethernet** is described in chapter 7.6 "Safety-Related Peer-to-Peer Communication".

6.1.3 Operating Parameters of the Ethernet Interfaces

Up to COM OS Version 8.32:

All Ethernet ports of the integrated Ethernet switches have the same settings Autoneg / Autoneg for Speed Mode and Flow-Control Mode. Other settings are not possible or are rejected by the controller during loading of configuration.

The Ethernet interfaces 10/100 BaseT of the HIMatrix devices have the following parameters:

Operating parameters	
Speed Mode	Autoneg
Flow-Control Mode	Autoneg

Other devices combined with HIMatrix devices must have the following network settings:

Admissible settings of other devices	
Speed Mode	Autoneg
Flow-Control Mode	Autoneg
or	
Speed Mode	Autoneg
Flow-Control Mode	Half-Duplex
or	
Speed Mode	10 Mbit/s or 100 Mbit/s
Flow-Control Mode	Half-Duplex

Non-admissible settings of other devices	
Speed Mode	Autoneg or 10 Mbit/s or 100 Mbit/s
Flow-Control Mode	Full-Duplex

From COM OS Version > 8.32 and ELOP II Hardware Management Version 7.56.10:

For each Ethernet port of the integrated Ethernet switch the parameters could be set individually (see chapter 6.1.4).

6.1.4 Configuration of the Ethernet Switch

For HIMatrix devices in the register "Extended" the parameters "Speed Mode" and "Flow-Control Mode" must be set to "Autoneg". The option "Activate Extended Settings" must be set in order that the parameters are activated (see Figure 5: Properties of the COM).

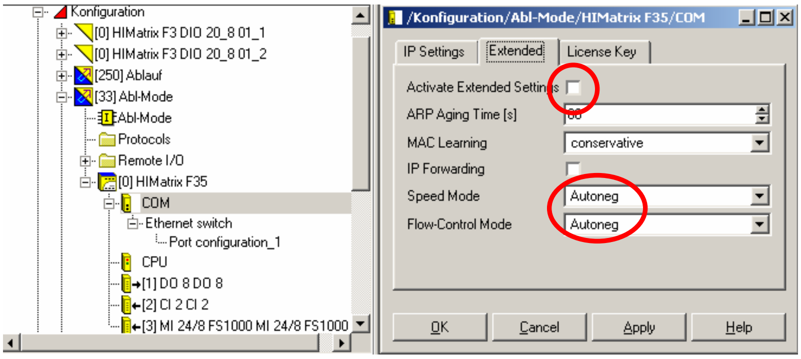


Figure 5: Properties of the COM

The parameters ARP, MAC Learning, IP Forwarding, Speed Mode and Flow-Control Mode are explained in detail in the online help of ***ELOP II Factory***.

The port settings of the integrated switch of a HIMatrix resource can be parameterized individually ***from COM OS Version > 8.32 and ELOP II Hardware Management Version 7.56.10 on***. Via the menu option *Ethernet switch* -> *New* -> *Port configuration* a configuration menu can be established for each switch port.

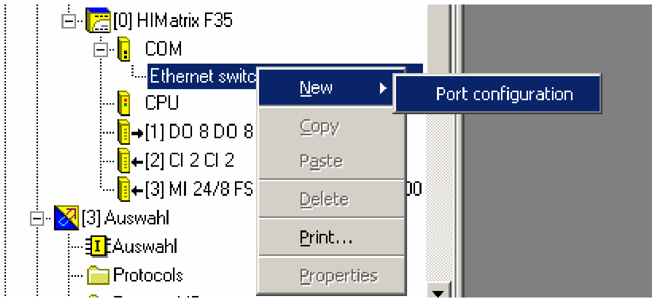


Figure 6: Setting a port configuration

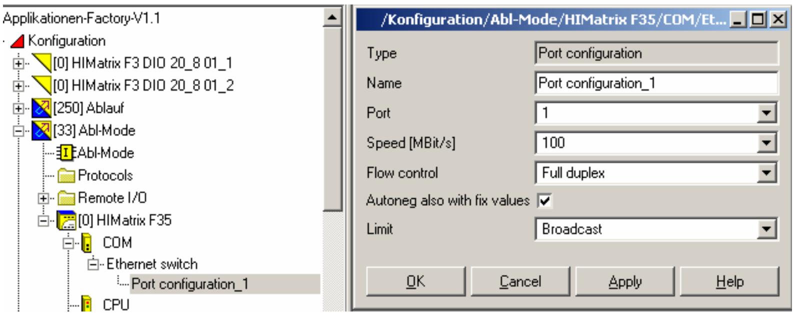


Figure 7: Parameter of a port configuration

<table>
<tr><th>Name</th><th>Description</th></tr>
<tr><td>Port</td><td>Number of port as on device; per port only one configuration is possible.
Value range: 1..n, depending on the resource</td></tr>
<tr><td>Speed [Mbit/s]</td><td>10 MBit/s: Data rate 10 MBit/s
100 MBit/s: Data rate 100 MBit/s
Autoneg (10/100): Automatic setting of the baud rate
Default: Autoneg</td></tr>
<tr><td>Flow-Control</td><td>Full duplex: Communication in both directions at the same time
Half duplex: Communication in one direction at the same time
Autoneg: Automatic control of communication
Default: Autoneg</td></tr>
<tr><td>Limit</td><td>Limit incoming Multicast and/or Broadcast packages.
Off: no limit
Broadcast: limit Broadcast (128 kbit/s)
Multicast and Broadcast: limit Multicast and Broadcast (1024 kbit/s)
Default: Broadcast</td></tr>
<tr><td colspan="2">Option: Autoneg also with fix values
The "Advertising" (transfer of the properties of Speed und Flow-Control) is made also at fix values of the parameters “Speed” and “Flow-Control”.
Thereby other devices, whose port settings are ”Autoneg“, can recognize how the ports of the HIMatrix are set.</td></tr>
</table>

Table 6: Parameters of the port configuration

The parameters are set in the configuration of the COM of the HIMatrix controller by pushing the button *Apply.* The entries in the properties of the COM and of the Ethernet switches (configuration) must be compiled anew with the application program and transferred in the controller before the entries can become active for the communication of the HIMatrix. The properties of the COM and the Ethernet switches can also be changed directly online via the Control Panel. These settings become active at once, but are not transferred into the application program.

6.1.5 Connections for Safeethernet/Ethernet

For the networking via safe**ethernet**/Ethernet the other F60 modules or HIMatrix compact systems devices the CPU is equipped with four connections arranged at the front of the housing.

Safeethernet/Ethernet Networking example:

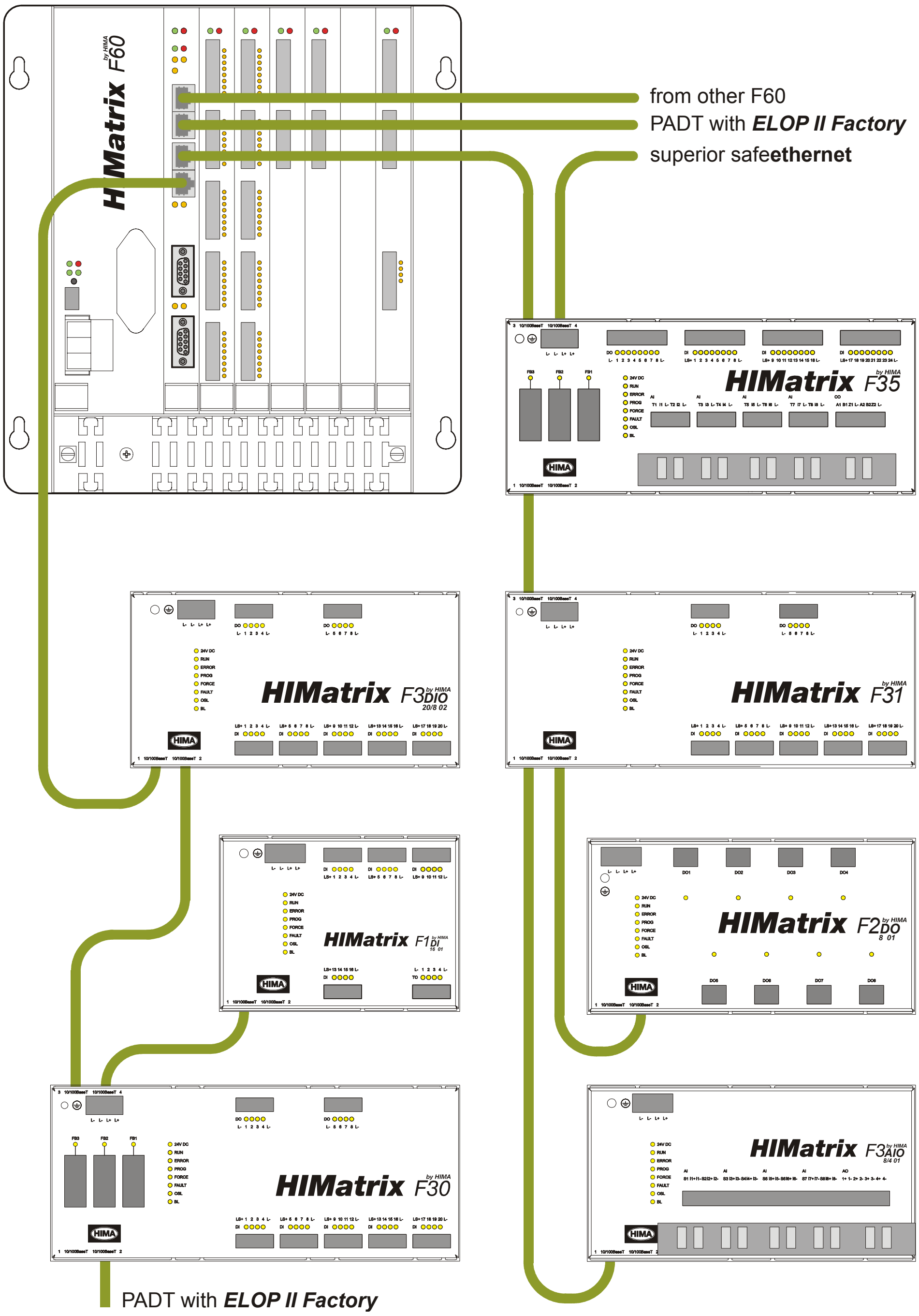


Figure 8: Safeethernet/Ethernet Networking example

The various systems can be networked together as required via Ethernet (star or line configuration). A programming unit (PADT) can also be connected wherever required.

Note	Make sure that no network rings are formed when connecting systems together. A system must receive data packets on only *one* path.

6.2 Field Bus Communication

Both interfaces FB1 and FB2 are able to communicate with master or slave systems via field bus. For this purpose the Profibus-DP protocol or the Modbus protocol can be used.

Both interfaces can operate simultaneously.

Note	During a reset of the controller the field bus interfaces may not be connected to a field bus in operation, as this will result in malfunctions there.

6.3 Communication Interfaces of the CPU

6.3.1 Connections for Ethernet Communication

Designation	Connection	Function
1 10/100BaseT	RJ-45	*Safety-related*: safe**ethernet** *Not safety-related:* PADT, OPC, Ethernet/IP, TCP-SR, SNTP, Modbus-TCP
2 10/100BaseT	RJ-45	*Safety-related*: safe**ethernet** *Not safety-related:* PADT, OPC, Ethernet/IP, TCP-SR, SNTP, Modbus-TCP
3 10/100BaseT	RJ-45	*Safety-related*: safe**ethernet** *Not safety-related:* PADT, OPC, Ethernet/IP, TCP-SR, SNTP, Modbus-TCP
4 10/100BaseT	RJ-45	*Safety-related*: safe**ethernet** *Not safety-related:* PADT, OPC, Ethernet/IP, TCP-SR, SNTP, Modbus-TCP

Table 7: Connections for Ethernet communication

6.3.2 Connections for Field Bus Communication

Designation	Connection	Function
FB 1 (RS 485)	SUB-D socket	Profibus master Profibus slave Modbus master RS485 Modbus slave RS485 Interbus master
FB 2 (RS 485)	SUB-D socket	Profibus master Profibus slave Modbus master RS485 Modbus slave RS485 Interbus master

Table 8: Connections for field bus communication

All the connections for communication are located on the front plate of the CPU module (description in the data sheet).

6.4 IP Address and System ID (SRS)

A transparent label is provided with the CPU and can be used to note the IP address and system ID (SRS, System-Rack-Slot) following to a modification:

IP___.___.___.___SRS____.__.__

Default value for IP address: 192.168.0.99

Default value for SRS: 60000.0.0

(rack and slot not changeable)

The ventilation slots in the housing of the controller must not covered with the label.

How to change the IP address and system ID is described in the ***ELOP II Factory*** manual "First Steps".

7 Operating Systems

7.1 Functions of the CPU Operating System

The operating system program contains all the *basic* functions of the HIMA HIMatrix Programmable Electronic System (PES).

The *user* functions that should be carried out by the relevant PES are specified in the application program with the software package ***ELOP II Factory***. A code generator is used to translate the application program into machine code, which is then transferred into the Flash EPROM in the central module.

The main functions of the operating system and the relevant connections to the application program are displayed in the following table:

Functions of the operating system	**Connection to application program**
Cyclic processing of the application program	Affects variables, function blocks
Configuration of the programmable controller	Determined by selection of PES
CPU tests	- - -
I/O module tests	Dependent on type
Reactions in event of a fault	Specified; application program is responsible for process reaction
Diagnosis for CPU and I/O	Use of system signals for error messages
Safety-related communication: Peer-to-Peer Non-safety-related communication: Profibus-DP, Modbus, Interbus	Determination of use of communication signals
PADT interface: Permitted operations	Determined in ***ELOP II Factory***: Configuration of protective functions, user log-in

Table 9: Functions of the CPU operating system

Each operating system is TÜV tested and is approved for operation with the safety-related PES. The current versions of the operating system and the relevant signatures (CRCs) are subject to revision control, and are documented in a list, which is created together with the TÜV.

7.2 Response to Faults

7.2.1 Permanent Faults

A fault occurring in the input or output channel has no effect on the controller. Only the defective channel is interpreted as faulty but not the entire controller. The remaining safety functions are not affected and remain active.

In the case of defective input channels, the operating system passes the safe value "0" to be processed. Defective output channels are set to a deenergized state. If it is not possible to disconnect a single channel, the whole output module is interpreted as defective.

The fault status signal is set and the CPU signals the type of fault to the application program.

If the CPU cannot switch off the output on demand and even the secondary means of deenergization is not effective the CPU goes into the STOP state. The outputs then are switched off by the CPU's watchdog.

In the case of faults in the I/O modules, which last for more than 24 hours, the concerning I/O modules will be switched off permanently.

7.2.2 Temporary Faults at Inputs/Outputs

If a fault occurring in the input or output module disappears again of its own accord, the fault status is reset and normal operation is resumed.

The frequency with which faults occur is statistically evaluated. If the specified fault frequency is exceeded, the status of the module is permanently set to "defective". The module doesn't operate even after the fault has disappeared. The release of the module and the erase of the fault statistic can be managed by changing the CPU state from STOP to RUN. With this change the fault of the module will be receipted.

7.2.3 CPU Faults

If a fault is detected in the CPU, it goes into ERROR STOP, and all outputs are set to the safe (deenergized) state.

7.3 The CPU

The CPU is the central component of the controller and communicates with the other I/O modules via the I/O bus. Data exchange via the communication module is carried out with a Dual-Port RAM.

The CPU monitors the operation and the correct performance of the operating system and application program. The following functions are periodically monitored:

- Self-tests for the CPU hardware and software,
- RUN cycle of the CPU (including application program),
- I/O tests and processing of I/O signals.

7.3.1 Operating Status of the CPU

The operating status of the CPU is indicated via LEDs on the front plate of the unit. However, like other additional signals and parameters, it can also be interrogated via the programming unit.

When the CPU stops, the execution of the application program is interrupted; its outputs and all I/O modules are set to safe values.

Employing a logic that sets the *Emergency stop* system signal to TRUE (see Chapter 7.4.1) will put the CPU into the STOP mode.

The most important operating states are summarized below:

Operating state	Description
INIT	Safe state of CPU during initialization Hardware and software tests are carried out.
STOP	Safe state of CPU without execution of an application program All controller outputs are reset. Hardware and software tests are carried out.
RUN	The CPU is active: The application program is being executed, I/O signals are processed. The CPU carries out safety-related and non-safety-related communication (when configured). Hardware and software tests are carried out, as well as tests for configured I/O modules.
ERROR STOP	Safe state of CPU after a system fault. All controller outputs are reset, the hardware watchdog is not triggered. A reboot of the CPU can only take place via the PADT.

Table 10: Operating states of the CPU

7.3.2 Configuration of the CPU

The CPU must be configured before it can carry out its tasks. The parameters and switches for the configuration are saved in the NVRAM (non-volatile RAM) and in the Flash File System of the communication module.

The following system parameters can be set for the CPU:

Parameter/ switch	Range	Description	Default
System ID	1 to 65 535	System identification in network	0 (invalid)
Safety Time	20 to 50000 ms	Safety time of the controller (not of the whole process)	2 ∗ Watchdog Time
Watchdog Time	≥ 10 ms ≤ (safety time) / 2 ≤ 5000 ms	Max. permitted time of a RUN cycle. The CPU goes into ERROR STOP if the cycle time is exceeded.	F60: 50 ms
Main Enable	On/Off	The main enable can only be switched to "On" in STOP and ERROR STOP operating states. Allows the change of the switches listed below and of the parameters "Safety Time" and "Watchdog Time" to be changed in **RUN** state.	On
Autostart	On/Off	Automatic start of CPU after Power ON (automatic transition from STOP to RUN)	Off
Start/Restart allowed	On/Off	Start command for the CPU On: Start (cold start) or restart (warm start) command accepted by the CPU Off: Start/restart not allowed	On
Loading allowed	On/Off	Loading an application program On: Loading allowed Off: Loading not allowed	On
Test Mode allowed	On/Off	On: Test mode allowed Off: Test mode not allowed	Off
Online Test allowed	On/Off	On: Online Test mode allowed Off: Online Test mode not allowed	On
Forcing allowed	On/Off	On: Forcing allowed Off: Forcing not allowed	Off
Stop on Force Timeout	On/Off	STOP during operation of Forcing time	On
Max. COM time slice	2 to 5000 ms	Time to complete communication tasks	10 ms
Code Generation Version	3	Code generation suitable for hardware operating system	3

Table 11: Configuration of the CPU

The configuration of a CPU for the safety-related operation is described in the HIMatrix system **Safety Manual**.

7.3.2.1 Setting CPU System Parameters with Code Generation

The CPU system parameters are available via the resource of the HIMatrix controller (***ELOP II Factory Hardware Management***).

- Click the right mouse button on the resource and select the option *Properties*. The following window will open:

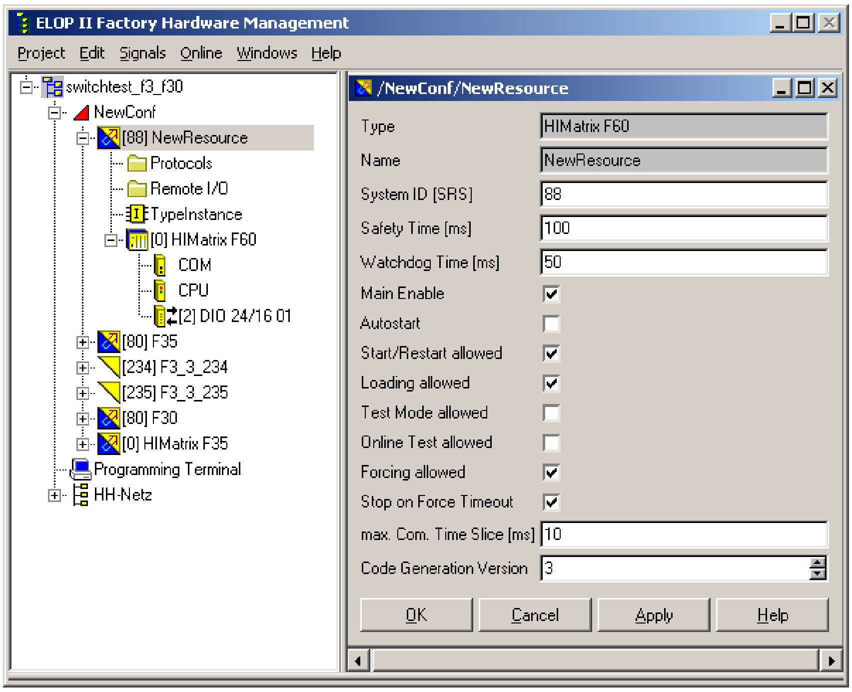


Figure 9: CPU system parameters

- Values can be inserted in the fields or options can be set by marking the according checkbox. The values will be put into the resource configuration by clicking on *OK*. Saving of the project is not necessary.

Note	Changes of the CPU system parameters will only be active in the controller if the code of the application program was newly generated and loaded into the controller.

7.3.2.2 Setting CPU System Parameters without Code Generation

Note	Most of the CPU system parameters can also be set directly (online) in the controller via ***ELOP II Factory Hardware Management*** and are activated with the next cycle of the controller. During setting the controller can be in the STOP state or the RUN state.

For direct setting of the CPU system parameters go to ***ELOP II Factory Hardware Management***.

- Select the desired resource and click the right mouse button.
- Via menu *Online -> Control Panel* the window of the control panel opens.
- For activation/deactivation of the CPU system parameters the switch *Main enable* must be set.

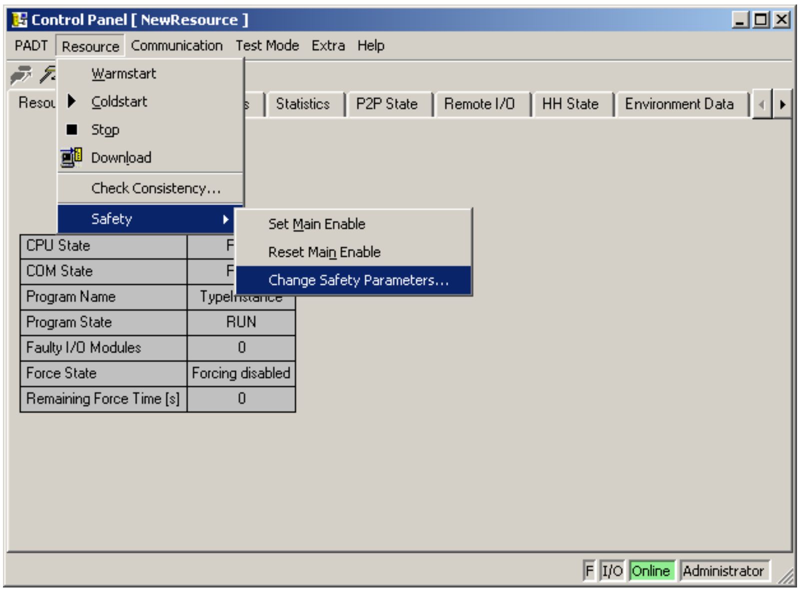


Figure 10: Setting CPU system parameters in the controller

- Via menu *Resource -> Safety* first set the switch for main enable and second select the option *Change Safety Parameters*.

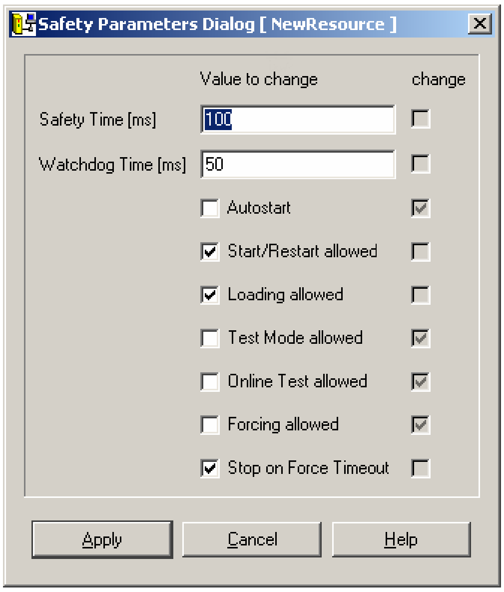


Figure 11: Setting the CPU system parameters/safety parameters directly in the controller

- Values can be inserted in the fields or options can be set by marking the according checkbox. The flag "change" displays which parameter is changed by clicking on *Apply*. By pressing the button *Apply* the flag vanishes and the changed parameters will be active in the controller with the next cycle.
- The overview in the register "Safety parameters" of the control panel shows, which CPU system parameters/safety parameters are actually active in the controller.

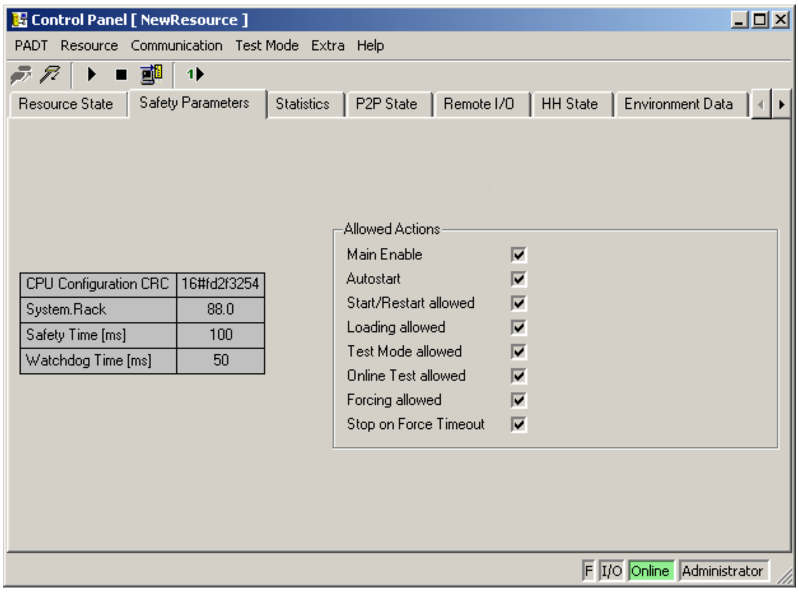


Figure 12: Display of the actually valid CPU system parameters/safety parameters

7.3.2.3 Maximum Communication Time Slice

The maximum communication time slice is a parameter, which is necessary for the parameterization of the peer-to-peer communication (see chapter 7.6). It is the time in milliseconds per CPU cycle, in which the CPU must have processed all communication tasks.

The minimum amount of time required is dependent on the number "n" of communication partners a controller has. This value is normally smaller than the total number of all controllers in a Token Group or network.

The **minimum communication time slice** CTS_{min} is calculated as follows:

For n ≤ 13:	For n > 13:
CTS_{min} (n ≤ 13) = n * 1 ms + 4 ms	CTS_{min} (n > 13) = n * 1.3 ms

n: the number of communication partners of a controller

Note	Never set the value for the maximum communication time slice below the calculated minimum value.

If the communication time slice chosen is too small, there is a risk that not all communication tasks present in a CPU cycle will be carried out. This impairs the quality of the data transfer and can cause the communication path to close if the time parameters conflict with each other.

The time required for communication is added to the CPU cycle time. A low value for the communication time slice limits the total cycle time and prevents the total cycle time from being noticeably affected by what's happening on the network.

The communication time slice should only be set under the minimum value CTS_{min} if the local application program in the controller has a higher priority than communication with other controllers, and if the local application program has not to be affected by varying network loading.

There is no negative effect if the value for the communication time slice is set well above the minimum value. It simply means that the cycle time of the controller will increase slightly when there is a heavy load on the network.

Note	It is perfectly acceptable to set the communication time slice so that the total cycle time does not exceed the watchdog time specified by the process.

Note	If a small communication time slice is set, we strongly recommend that the CPU short-term diagnostic is checked for "Time Slice expired" entries and to increase the communication time slice, if required, before the application starts regular operation.

The number of required communication time slices could also be seen in the register "Statistics" in the *Control Panel*.

The **maximum communication time slice** CTS_{max} is dependent on the application and is calculated as follows:

$$\text{Watchdog time} \geq CTS_{max} + \text{execution time of the application}$$

If the communication path being used is slow or is heavily loaded, the communication time slice must be set substantially higher than the CTS_{min} , but lower than the CTS_{max}.

Example:

Consider an application in which three controllers are present.

The controller to be configured communicates with both of the other controllers (n = 2).

The minimum required communication time slice is

$$CTS_{min} = 2 * 1\ ms + 4\ ms = \mathbf{6\ ms}.$$

As the local application is not as important as the entire process, CTS_{min} is increased by several milliseconds to be able to compensate better for heavier network loads.

$$CTS_{min} = \mathbf{20\ ms}$$

If the watchdog time is 500 ms, 480 ms remain in which to execute the application program.

7.3.3 Programming

To program the HIMatrix devices, a PADT (programmer unit, PC) running the programming tool

ELOP II Factory

and the program languages Function Block Diagram (FBD) and Sequential Function Chart (SFC) in accordance to IEC 61131-3 are used. This software assists the user in creating safety-related programs and operation of the PES.

7.4 System Signals

7.4.1 General System Signals and Parameters

Signal	[Data type], Unit, value	R/W	Meaning
System ID high/low	[USINT]	R	System ID of the CPU (first part of SRS)
OS Major version OS Major High OS Major Low	[USINT]	R	Major version of the CPU operating system (OS) Example: OS version 6.12, Major version: 6 from OS version 6, valid if System ID ≠ 0
OS Minor version OS Minor High OS Minor Low	[USINT]	R	Minor-Version of the CPU operating system (OS) Example: OS version 6.12, Minor version: 12 from OS version 6, valid if System ID ≠ 0
Configuration signature CRC Byte 1-4	[USINT]	R	CRC of the loaded configuration; only valid in the operating states RUN and STOPP VALID CON-FIGURATION. from OS version 6, valid if System ID ≠ 0
Date/time [seconds part] and [ms part]	[USINT] s ms	R	 Seconds since 1970 with ms An automatic changeover between winter time / summer time is not supported.
Remaining Force Time	[DINT] ms	R	Remaining time during Forcing; 0 ms if Forcing is not active
Fan State	[BYTE] 0x00 0x01	R	 normal (fan running) fan faulty
Power Supply State	[BYTE] 0x00 0x01 0x02 0x03 0x04 0x10 0x20 0x30 0x40	R	 normal Error with 24V voltage Error with battery Error with 5 V power supply Error with 3.3 V power supply 5 V undervoltage 5 V overvoltage 3.3 V undervoltage 3.3 V overvoltage
System Tick High/Low	[UDINT] ms	R	Ring counter 64 bit Each 32 bits are combined into a UDINT
Temperature State	[BYTE] 0x00 0x01 0x02 0x03	R	 normal high faulty very high
Cycle Time	[UDINT] ms	R	 Duration of last cycle
Emergency Stop 1, 2, 3, 4	TRUE, FALSE	W	TRUE: System emergency stop
Relay Contact 1, 2, 3, 4	TRUE, FALSE	W	TRUE: Contact closed Common contact on power supply module (see data sheet PS 01), controlled by four OR inter-locked system signals

Table 12: General system signals and parameters

- The general system signals and parameters of the system (CPU) are available in ***ELOP II Factory Hardware Management*** via CPU and sub menu *Signal Connections*.
- In the register "Inputs" of the Signal Connections the following signals can be read:

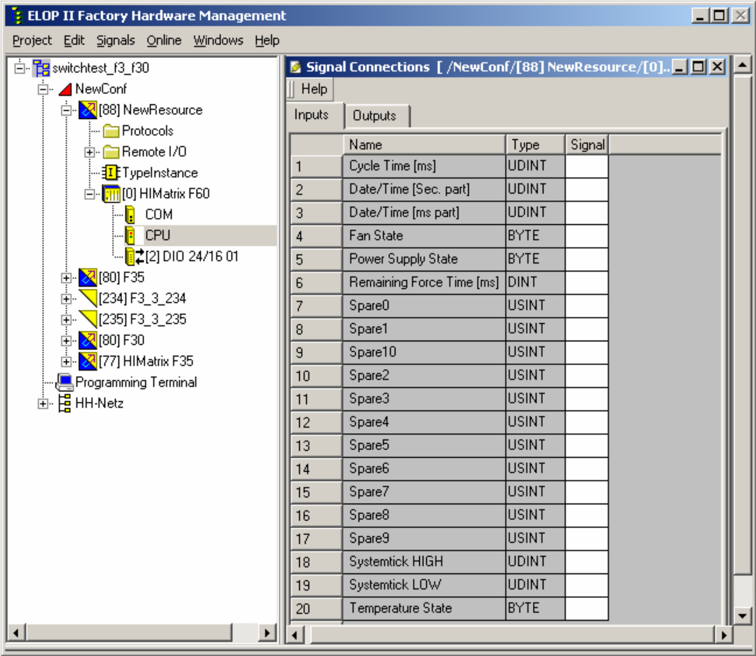


Figure 13: CPU system inputs

- In the register "Outputs" of the Signal Connections one can set for example Emergency Stop signals:

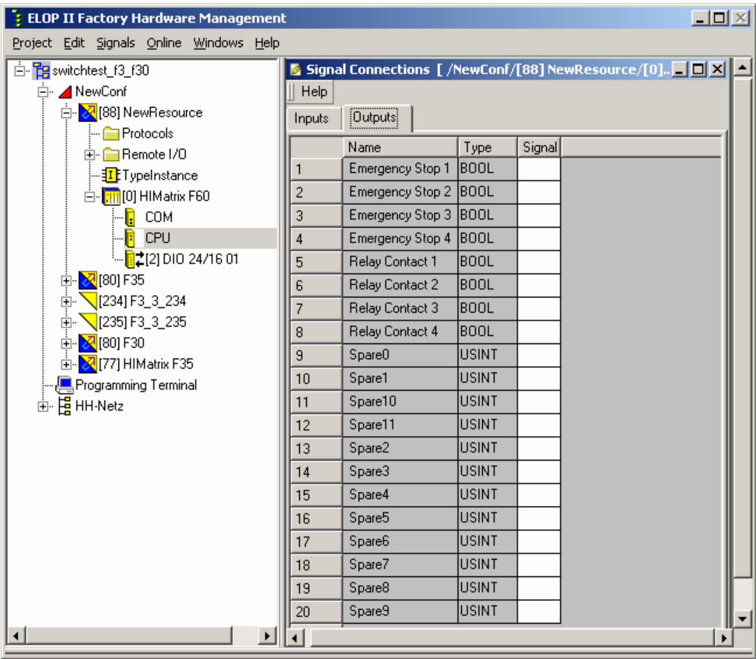


Figure 14: CPU system outputs

Defined signals from the Signal Editor can be correlated to existing hardware channels/parameters (inputs and outputs) in the Signal Connections. These signals could be read or set via the logic of the application program (see chapter 7.5).

7.5 Configuration of the Inputs and Outputs

With the use of the software ***ELOP II Factory*** the previously via signal editor defined signals (hardware management) could be assigned to the single existing hardware inputs and outputs.

Follow the further steps in ***ELOP II Factory Hardware Management***:

- Open Signal Editor in menu *Signals*.
- Right-click on the HIMatrix I/O module and select *Connect Signals* in the context menu.
- A new window opens for allocating the logic signals of the Signal Editor to the existing hardware signals, i.e. the inputs and outputs (different registers).

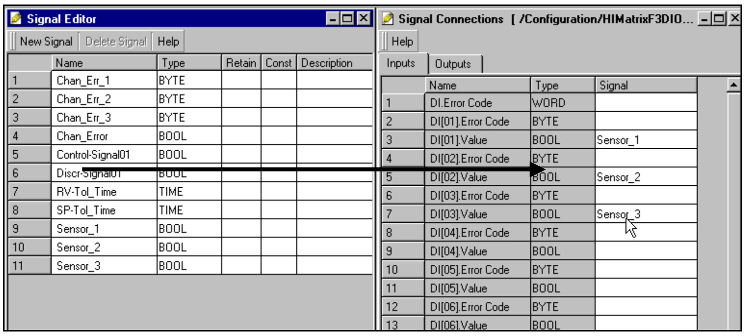


Figure 15: Drag & drop allocating of signals to the inputs

- For better overview you can tile both windows of Signal Editor and Signal Connections side by side.
- In the Signal Editor click on a signal name and drag the signal into the "Signal" column (used channel, input) of the "Signal Connections" window.
- For signal connection of the outputs change the register to "Outputs" and do in the same way as for the inputs.

Signals available for signal connections in the controller will be found in the chapter "Signals and Error Codes of the Inputs and Outputs" of the corresponding controller.

The following notes are correlated to the register "Inputs" or "Outputs" of the window "Signal Connections":

Note The signals for the error codes of the hardware channels are always located in the register "Inputs".

The signals for the parameterization or configuration of the hardware channels are located in the register "Outputs" no matter whether they are physical inputs or outputs.

The value of the hardware channel for a physical input is always located in the register "Inputs", the value for the channel for a physical output is located in the register "Outputs".

7.6 Safety-Related Peer-to-Peer Communication

Peer-to-Peer (P2P) communication is used to exchange data between two controllers in a network with several participants. All controllers are Peer-to-Peer capable and can be interconnected without any restrictions.

The controllers are usually connected via HIMA safe**ethernet**. However, by using Gateways beyond LANs, other communication media can be used, for example radio relay or glass fiber.

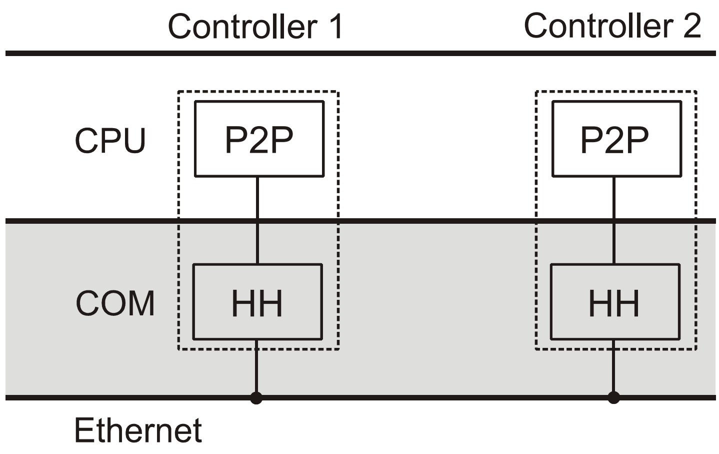


Figure 16: Peer-to-Peer block diagram

The controllers (Controller 1... n) are each fitted with at least two 100 BaseT Ethernet interfaces. The controller can be a HIMatrix or a remote I/O used in a Peer-to-Peer network. The HH protocol is integrated in the operating system of the communication module COM and interacts with the Ethernet connections (see Figure 16: Peer-to-Peer block diagram). The HH protocol is based on the UDP/IP and IEEE 802.3 standards and is responsible for the transfer via Ethernet.

The *Peer-to-Peer protocol* is integrated into the safety-related operating system of the CPU. The CPU uses the COM communication module as a deterministic transfer channel.

The Peer-to-Peer protocol is mainly responsible for

- communication between the central modules of the controllers as well as the remote I/O modules, including the automatic establishment of a connection,
- extended diagnostics,
- all safety-relevant properties to ensure correct exchange of data.

Note	The Peer-to-Peer protocol is safety-related according to IEC 61508 (SIL 3), EN 954-1 (CAT 4).

7.6.1 System Signals of a Peer-to-Peer Connection

The status of the Peer-to-Peer communication and some of the time parameters can be evaluated in the application program via system signals. An application program can also control, via signal *Connection Control*, how a Peer-to-Peer connection is established.

Four system signals are used as inputs, the system signal *Connection Control* is used as output in a logic program.

The following signals are available in a Peer-to-Peer communication:

Input signals	[Data type]/Unit, value	R/W	Meaning
Receive Timeout	[UDINT] ms	R	Time in ms, maximally passing between the receiving of two valid messages
Response Time	[UDINT] ms	R	Time in ms, waiting for a response to the last transmitted message
Connection state	[UDINT] 0 (CLOSED) 1 (TRY_OPEN) 2 (CONNECTED)	R	CLOSED: no connection TRY_OPEN: try to establish the connection (status applies for active and passive peer) CONNECTED: connection established, data exchange and time monitoring activated
Version	[WORD]	R	Signature of the communication version
Input signal	**[Data type]/Unit, value**	**R/W**	**Meaning**
Connection Control	[WORD] 0x0000 0x0100 0x0101 0x8000	W	 AUTOCONNECT TOGGLE_MODE_0 TOGGLE_MODE_1 DISABLED With that the application program can close the safety-related protocol or release it for operation

Table 13: System signals of a Peer-to-Peer connection

The signal *Connection Control* has the following settable values:

Command	Description
AUTOCONNECT	After an interrupt of the Peer-to-Peer communication the controller tries to re-establish the communication in the next CPU cycle. This is the default value.
TOGGLE MODE 0 TOGGLE MODE 1 Usage: Operator Acknowledge	After an interrupt the communication can be re-established by a program controlled change of the TOGGLE MODE. If TOGGLE MODE "0" and the communication is interrupted (Connection State = CLOSED), a reconnect starts after the TOGGLE MODE was set to "1" by the application program. If TOGGLE MODE "1" and the communication is interrupted a reconnect starts after the TOGGLE MODE was set to "0" by the application program.
DISABLED	Peer-to-Peer communication is switched off. No attempt to connect.

Table 14: Parameter *Connection Control*

Switch to ***ELOP II Factory Hardware Management****:*

Read input signal

- Select the resource with the right mouse and open the *Peer-to-Peer-Editor* in the sub menu.
- Select the line with the desired resource.
- Click on the button "Connect System Signals" and select the register "Inputs".

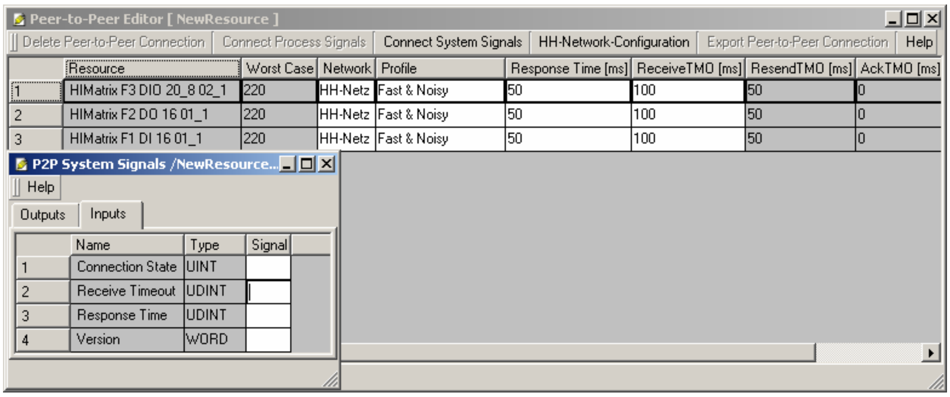


Figure 17: Peer-to-Peer parameters in register "Inputs"

The system signals *Receive Timeout*, *Response Time*, *Connection State* and *Version* can be read out via signal connections in the application program (see also chapter 7.5).

Configure output signal

- Select the resource with the right mouse button and open the *Peer-to-Peer-Editor* in the sub menu.
- Select the line with the desired resource.
- Click on the button "Connect System Signals" and select the register "Outputs".
- Via signal *Connection Control* in register "Outputs" the user can control how a Peer-to-Peer connection will be established.

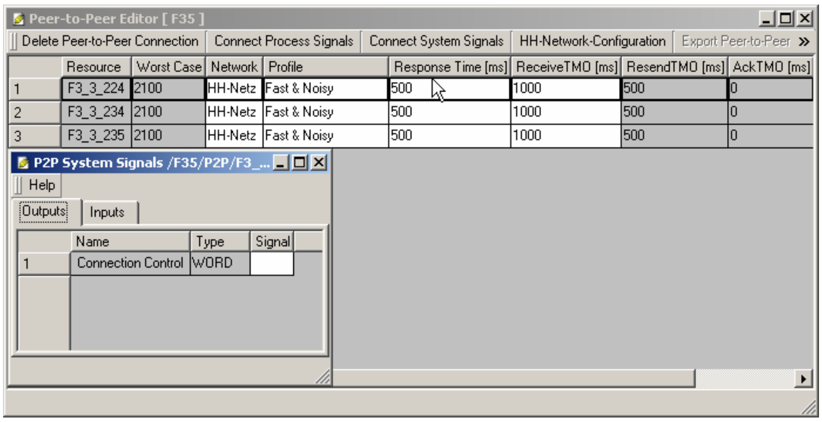
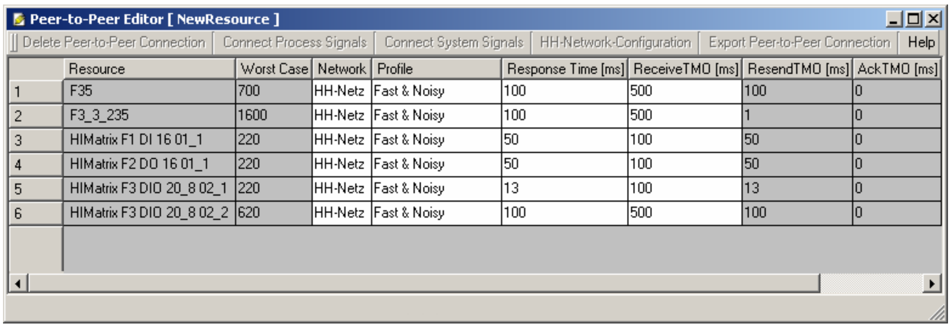


Figure 18: System signal *Connection Control* in register "Outputs"

7.6.2 Configuration of a Peer-to-Peer Connection

The following parameters can be set in the Peer-to-Peer-Editor defining a Peer-to-Peer communication of a resource:

1. Profil
2. Response Time
3. Receive TMO


Peer-to-Peer Editor [NewResource]
Delete Peer-to-Peer Connection | Connect Process Signals | Connect System Signals | HH-Network-Configuration | Export Peer-to-Peer Connection | Help

	Resource	Worst Case	Network	Profile	Response Time [ms]	ReceiveTMO [ms]	ResendTMO [ms]	AckTMO [ms]
1	F35	700	HH-Netz	Fast & Noisy	100	500	100	0
2	F3_3_235	1600	HH-Netz	Fast & Noisy	100	500	1	0
3	HIMatrix F1 DI 16 01_1	220	HH-Netz	Fast & Noisy	50	100	50	0
4	HIMatrix F2 DO 16 01_1	220	HH-Netz	Fast & Noisy	50	100	50	0
5	HIMatrix F3 DIO 20_8 02_1	220	HH-Netz	Fast & Noisy	13	100	13	0
6	HIMatrix F3 DIO 20_8 02_2	620	HH-Netz	Fast & Noisy	100	500	100	0

Figure 19: Setting parameters in the Peer-to-Peer-Editor

The parameters mentioned above determine the data rate as well as the error and collision tolerance of a Peer-to-Peer connection.

corresponding to 1. **Profile:**

Due to the large number of parameters, the manual network configuration is very complex and requires a good knowledge of parameters and their mutual effect.

To simplify the settings, there are **six Peer-to-Peer profiles** available, from which the user can select the one best suited to the application and network.

Profiles are combinations of compatible parameters that are automatically set when the user selects one of the profiles.

The aim of each profile is to optimize data throughput in the network by taking the physical conditions into account.

The profiles I to VI are described in detail at online help of ***ELOP II Factory Hardware Management.***

Note	For calculations of the reaction times ReceiveTMO and Worst Case Reaction Time take a look at HIMatrix Safety Manual chapter 7, Configuration of the Communication.

corresponding to 2. **Response Time:**

The Response Time is the time, which elapses before the sender of the message receives acknowledgement from the recipient.

The Response Time is not a parameter that can be freely configured; it is a result of the physical conditions of the transmission path, the cycle times of the receiver and of the configuration of the network protocol.

The Response Time influences the ability for failure tolerance, e.g. at package losts (resend of lost data packages is faster) or delays on communication path. A test run is recommended to examine the actual Response Time. An optimization of the Response Time increases the capacity and availability of the network.

In the *P2P State* tab on the Control Panel, the last, average, minimum and maximum Response Times are displayed.

The minimal, expected Response Time is calculated as follows:

Response Time = $T_{GR1} + T_1 + T_{GR2} + T_3 + T_2$

T_{GR1}	Delay of a message between two controllers: **CPU_1 -> COM_1 -> Network -> COM_2 -> CPU_2**
T_1	Time required to process all protocol stacks on CPU_2 T_1 = Cycle time(CPU_2) * n_2 where n_2 is the number of cycles required by CPU_2 to process all protocol stacks. It is recommended to set the Communication Time Slice (see chapter 7.3.2.3) large enough so that all protocol stacks can be processed in one cycle.
T_2	Delay of the acknowledgement message on CPU_2 T_2 = AckTMO + n_2 * {0 … Cycle time(CPU_2)} If AckTMO[1)] = 0 or ProdRate[2)] = 0, then T_2 = 0 (normal case)
T_{GR2}	Delay of a message between two controllers: **CPU_2 -> COM_2 -> Network -> COM_1 -> CPU_1** (generally identical to T_{GR1})
T_3	Time required to process all protocol stacks on CPU_1 T_3 = Cycle time(CPU_1) * n_1 where n_1 is the number of cycles required by CPU_1 to process all protocol stacks. It is recommended to set the Communication Time Slice (see chapter 7.3.2.3) large enough so that all protocol stacks can be processed in one cycle.

1)
AckTMO is the maximum amount of time within which the CPU must acknowledge the receipt of a data packet.

AckTMO cannot be entered manually. It is set in the Peer-to-Peer Editor together with the profile selection.

For a fast network, AckTMO is zero, i.e. the receipt of a data packet is acknowledged immediately. On a slow network, (e.g. telephone modem line) AckTMO is greater than zero.

2)
Smallest time interval between two data packets.

The aim of ProdRate (Production Rate) is to limit the number of data packets to a figure that will not overload a (slow) communication channel. This ensures even loading of the transfer medium.

A Production Rate of zero indicates that data packets are transferred with each cycle of the application program. In the profile for fast networks this is the case.

The data and their acknowledges are sent so fast as cycle time and the protocol allow.

corresponding to 3. **ReceiveTMO:**

Monitoring time on PES_1 during which a correct response must be received from PES_2.

Note	ReceiveTMO also applies in the reverse direction, i.e. from PES_2 to PES_1.

The ReceiveTMO (safety-related) is part of the Worst Case Reaction Time T_R. The ReceiveTMO must be calculated and entered via the Peer-to-Peer Editor.

If the communication partner does not receive a correct answer within the ReceiveTMO the safety-related communication is closed and all signals imported over this communication channel will be set to the initial values defined by the user.

The following requirement must be met for a network in which potential lost of data packages could occur:

ReceiveTMO ≥ 2 * ResponseTime (minimum)

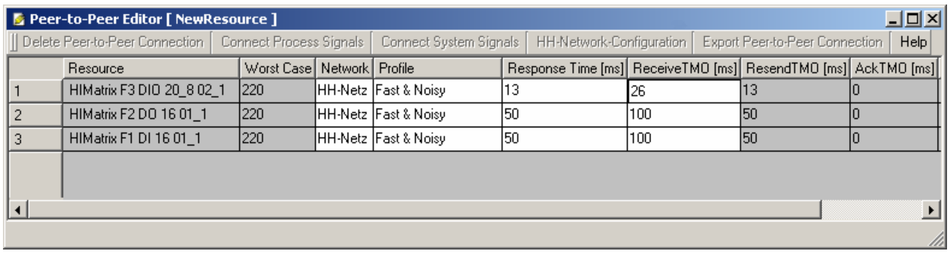
(valid for profile "Fast & Noisy")

If this requirement is met, the loss of at least one data packet can be tolerated without the Peer-to-Peer connection being dropped.

If this requirement is not met, the availability of a Peer-to-Peer connection can only be guaranteed in a network that is free of collisions and faults. However, this does not affect the safety of the CPU.

Note	The maximum permitted value for ReceiveTMO depends on the application process and is set in the Peer-to-Peer Editor together with the maximum expected ResponseTime and the profile.

Example values for parameters of a Peer-to-Peer connection:



	Resource	Worst Case	Network	Profile	Response Time [ms]	ReceiveTMO [ms]	ResendTMO [ms]	AckTMO [ms]
1	HIMatrix F3 DIO 20_8 02_1	220	HH-Netz	Fast & Noisy	13	26	13	0
2	HIMatrix F2 DO 16 01_1	220	HH-Netz	Fast & Noisy	50	100	50	0
3	HIMatrix F1 DI 16 01_1	220	HH-Netz	Fast & Noisy	50	100	50	0

Figure 20: Values for parameters of a Peer-to-Peer connection

7.6.3 Defining Process Signals of a Peer-to-Peer Communication

Peer-to-peer communication (direct data transfer between controllers) is currently only possible between controllers and the remote I/O modules of the HIMatrix family.

Two or more controllers exchange signals directly without requiring a communication master. Therefore a network (Token Group) must be set up first, the nodes (users) and their communication partners must be defined (see ***ELOP II Factory*** manual "First Steps").

After set up of the Peer-to-Peer network, the process signals for data transfer between the nodes could be defined.

- ❑ Click on a line number in the *Peer-to-Peer Editor* (left row). In this way the resource for data exchange is selected.

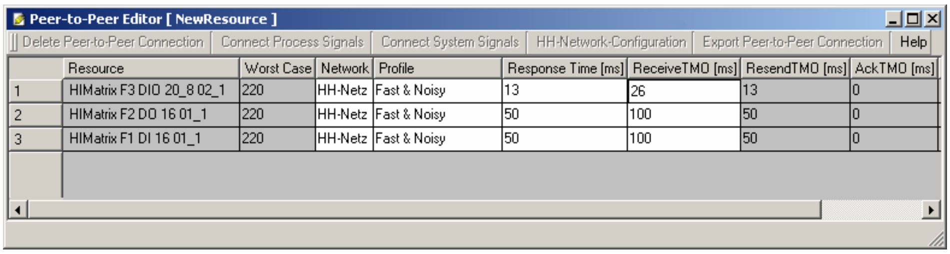


Figure 21: Connect process signals

- ❑ Select in the Peer-to-Peer Editor the option *Connect Process Signals*.
- ❑ The window of the Peer-to-Peer process signals is empty if you open it for the first time.
- ❑ Open the Signal Editor with *Signals -> Editor*.
- ❑ Place the windows of the Signal Editor and the Peer-to-Peer process signals side by side.

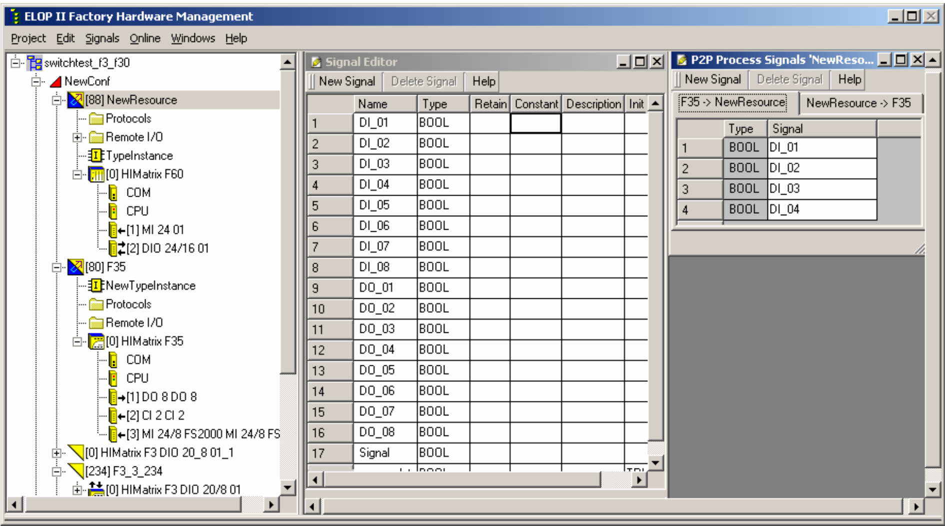


Figure 22: Allocating process signals with drag & drop

- Select the direction of communication by clicking on the corresponding register below the button menu.
- Move a signal name with drag & drop from the Signal Editor to the desired line in the window of the "P2P Process Signals".
- As an alternative you can use the button *New Signal*. In this case an empty row will be generated where you can insert the name of the signal with respect to upper and lower case.

Note	The transfer of a signal value from one controller to the other (PES_1 -> PES_2) makes this value available in the second controller PES_2. To use this value you have to choose the same signals in the logic of PES_1 and PES_2.

- Switch the direction of communication in choosing the corresponding register below the button menu and define the signals for the opposite direction.

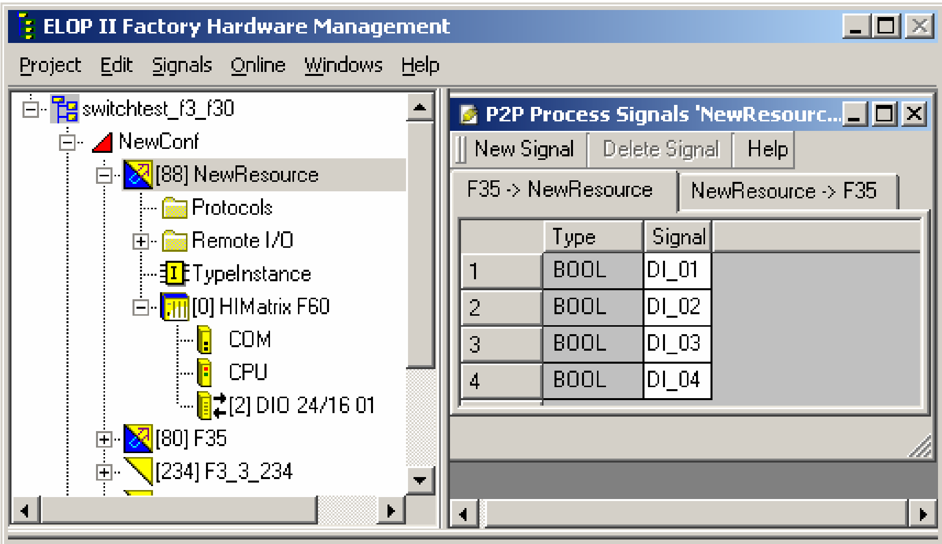


Figure 23: Example for process signals

Monitoring of transferred signals:

Always if a data package is sent the actual existing signal values of the PES are used.

As the PES cycle could be faster than the packages could sent not all values can be transferred. If the transfer/the reception of a value shall be ensured at the receiver the monitoring time at the sender must still run (ReceiveTMO) so he can get an acknowledge from the receiver. Alternatively an active receipt for the receiver can be programmed within the application program.

7.7 Loading New Operating Systems

The CPU and the COM have different operating systems, which are saved in rewritable Flash memories, and they can be replaced if necessary.

To load a new operating system via programming unit, the CPU must be in STOP.
Ensure that the safety tasks of the controller and/or the production process are not affected!

Note First the CPU operating system and second the COM operating system has to be loaded.

Note Loading of updates in RUN state of the CPU will be blocked and a message appears in hardware management.

Note If loading is interrupted or is ended incorrectly, the controller will not function correctly.
However, an operating system can be re-loaded.

If a connection with the controller is established (see ***ELOP II Factory*** manual "First Steps"), an update of an operating system can be managed via ***ELOP II Factory Hardware Management***:

- Select the desired resource und click on the right mouse button.
- Via the menu *Online* and the sub menu *Control Panel* you can open the window of the Control Panel.
- Via the menu *Extra* and the option *Update OS* binary files could be selected for loading a new update for CPU, COM or Profibus communication module.

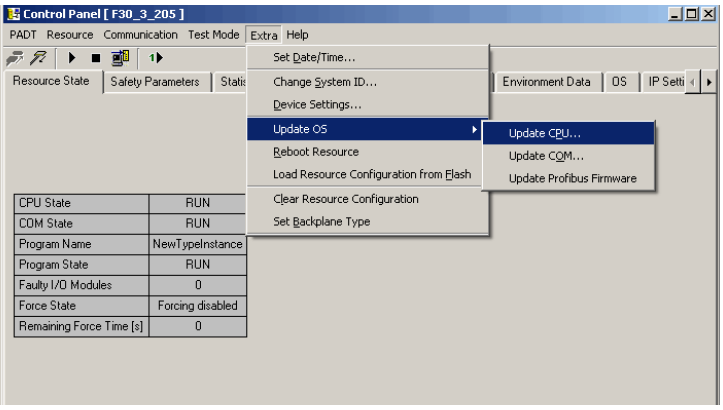


Figure 24: Loading new operating systems

After the loading has been successfully completed, the CPU boots up of its own accord with the new operating system.

If a program within the controller is loaded with *Autostart* to TRUE, this configuration is ignored and the CPU goes into STOP after booting up.

8 Application Program

The application program for the PES must be created and loaded using a programming unit running ***ELOP II Factory*** software according to IEC 61131-3 requirements.

Firstly, the application program is created using the programming unit and configured for the safe operation of the controller. The stipulations laid down in the Safety Manual must be obeyed and the conditions in the report accompanying the certificate must be fulfilled.

After it has been compiled, the application program (logic) and the configuration (connection parameters like IP address, subnet mask and system ID) are loaded into the controller using the programming unit and the controller is then started.

During operation, the programming unit (on which the same application program must be saved) can be used to force signals in the Force Editor and then display them. Test mode (single-step operation) is possible and the diagnosis can be read out.

8.1 Operating Modes of the Application Program

Only one application program can be loaded into a controller. The following operating modes are possible for this application program:

Operating mode	Description
RUN	The CPU is in RUN mode. The application program is executed cyclically, I/O signals are processed.
Test mode (single-step)	The CPU is in RUN mode. The application program is executed (triggered manually) cyclically, I/O signals are processed. **Not permitted for safety-related operation!**
STOP	The CPU is in STOP mode. • The application program is not executed (anymore), all outputs are reset. • Error in the application program.
ERROR STOP	The loaded application program is in ERROR STOP. All controller outputs are reset; the hardware watchdog is not triggered. Note: A reboot of the CPU can only take place via the PADT.

Table 15: Operating modes of the application program

8.2 Configuring the Application Program

The table lists CPU parameters and switches that can be used to configure the application program:

Parameter, switch	Range	Description	Default
Watchdog Time	≥ 10 ms ≤ (safety time) / 2 ≤ 5000 ms	Max. permitted time of a RUN cycle The CPU goes into ERROR STOP if the cycle time is exceeded.	F60: 50 ms
Autostart	Off, cold start, warm start (attribute of *TypeIn-stance*)**	Automatic start of application program after POWER ON	Cold start
Start/Restart allowed	On/Off	On: Start (cold start) or restart (warm start) command permitted from PADT Off: Start/restart not allowed	On
Test Mode allowed	On/Off	On: Test mode allowed Off: Test mode not allowed	Off
Online Test allowed	On/Off	On: OnlineTest allowed Off: OnlineTest not allowed	On

** Via menu *Properties* of *TypeInstance* of the corresponding resource the mode of Autostart can be selected.

Table 16: CPU parameters and switches

The CPU parameters are available via ***ELOP II Factory Hardware Management***.

- Click on the resource with the right mouse button and select the sub menu *Properties*. The following window opens:

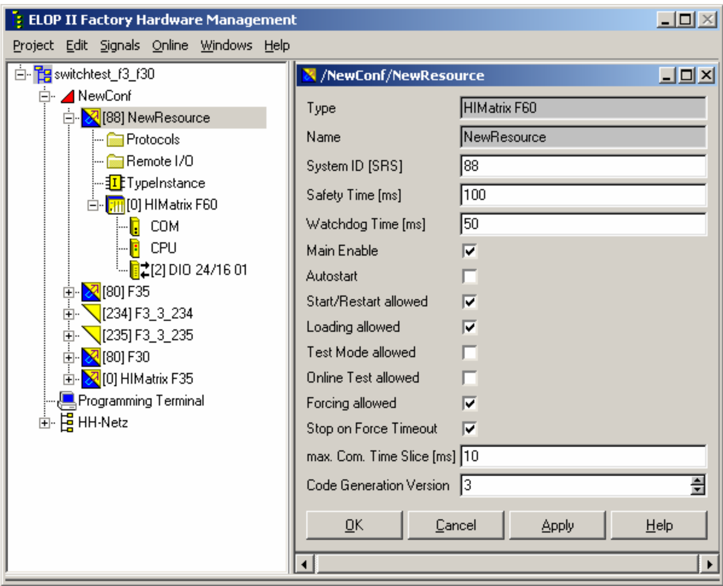


Figure 25: Configuration parameters of CPU/application program

- Values can be inserted in the input masks or options can be selected by marking the checkbox.
- The values for Autostart (off, cold start, warm start) can be selected via the menu *Proper-ties* of the *TypeInstance* of the corresponding resource. At cold start all signal values are initialized, at warm start all signal values of retain variables are buffered.

Further information about the force parameters of the CPU you will find in chapter 9, Forcing.

8.3 Code Generation of the Resource Configuration

Switch to the ***ELOP II Factory Project Management***:

- Select the HIMatrix resource in the project window.
- Open the context menu of the HIMatrix with the right mouse button and select the menu option *Code Generator*.
- The connection of the signals with the inputs/outputs will be generated in machine code.
- If code generation was successful (no red display/texts in error-state viewer), note the generated checksum.

Switch to ***ELOP II Factory Hardware Management***:

- Open the context menu of the HIMatrix resource with the right mouse button and select menu *About configuration*.

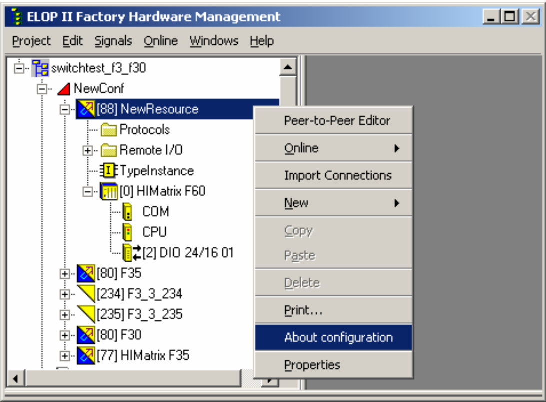


Figure 26: Opening configuration information

- Note the checksum for "root.config" in the column "CRC PADT".

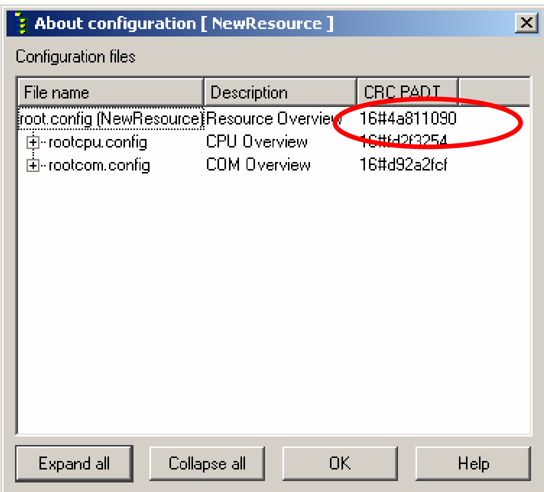


Figure 27: Noting checksum

- Generate the code for the resource again.
- Compare the checksum of the second code generation with the previously noted check-sum.

Note For safety-oriented applications the code generator must be started twice and the checksums (CRCs) of the two generated code versions must be compared. The code is guaranteed to be error-free only if the checksums are identical.

See the Safety Manual for additional details.

The code must only be loaded into the resource if the checksums are identical.

8.4 Load and Clear Resource Configuration

The loading of the resource configuration (configuration with or without an application program) is only possible in the CPU mode STOP. The switch *Loading allowed* of the CPU system parameters must be set (see chapter 7.3.2).

8.4.1 Configuring System ID and Connection Parameters

The System ID and the connection parameters have to be configured in the CPU module before the application program can be loaded via Control Panel.

Therefore change to ***ELOP II Factory Hardware Management*** and carry out the following steps:

- Select the corresponding resource and click the right mouse button.
- Select *Online* -> *Connection parameters*. The window for the overview of the PES connection parameters opens.
- Insert the valid MAC address for the controller into the corresponding field and push button *Set via MAC*. The configured connection parameters and the System ID of the project are set into the controller. See ***ELOP II Factory*** manual "First Steps".

8.4.2 Loading Resource Configuration after a Reset

If the Reset pushbutton was enabled at the CPU module the device is rebooted and the connection parameters as well as the user account (only controller) are set to default values, but only until a new reboot. Then the previous information is valid again.

If the connection parameters in the application program are changed these parameters could be changed in the CPU module according to chapter 8.4.1.

Loading a resource configuration at COM operating systems from V 10.42:
If the password of the user account is not known or a new user account should be used in the project, the default user must be set (administrator without password) after the setting of the connection parameters and before loading the application program into the CPU module.

Setting default user:
Open the context menu *Online* -> *Access Management* from the corresponding resource.

Push the button *Connect* to start the communication with the CPU module. Pushing the button *Default account* the access management will be erased in the CPU module and the default user will be set (administrator without password). Now the application program can be loaded into the CPU module.

Access Management with COM operating system version from V 6.0:
Via the menu *New* -> *Access Management* of the corresponding resource a new user can be created.

In the structure tree of the resource a new element *Access management* is created and the function *New* -> *Access Management* is locked. By clicking the element *Access Management* with the right mouse button a new user entry can be set via the context menu *New* -> *User*. Via the properties of the user in the context menu the user can be defined (name, password, etc.). Further users can be created in the same way.

After the code generation the new access management will be transferred into the CPU module by downloading the resource configuration. At the next login you can register as one of the users of the user list.

Further information concerning the Reset see ***ELOP II Factory*** manual "First Steps".

8.4.3 Loading Resource Configuration from Programming Unit

Before the application program with the connection parameters (IP address, subnet mask and System ID) can be loaded into the resource, the machine code for the resource must be generated and the programming unit and the resource must have valid communication settings (see also chapter 8.4.1).

- Select *Online -> Control Panel* in the resource context menu.

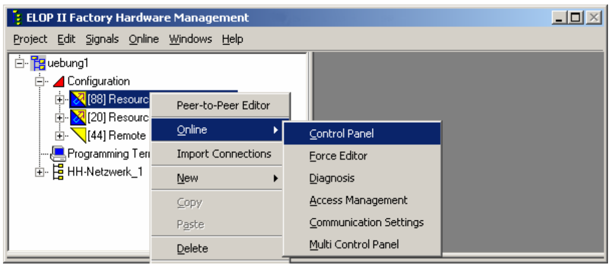


Figure 28: Opening the Control Panel

- Log in as administrator with the administrator access type or as user with write access.

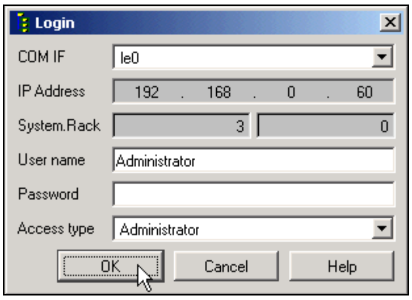


Figure 29: Entering user name and access type

- Load the application program. The controller must be in stop state. If necessary run *Resource -> Stop*.

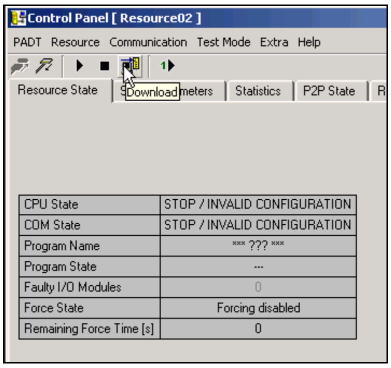


Figure 30: Control Panel

- Click the *Download* button . A prompt appears.

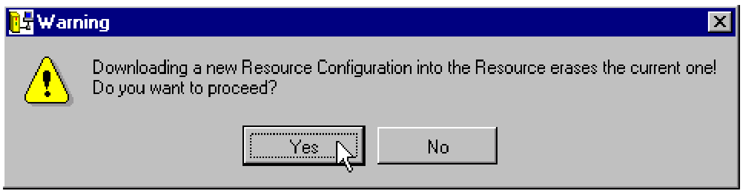
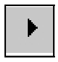


Figure 31: Prompt before download

- The download starts as soon as the prompt is acknowledged with *Yes*.

- After loading start the application program with click on the *Coldstart* button  .

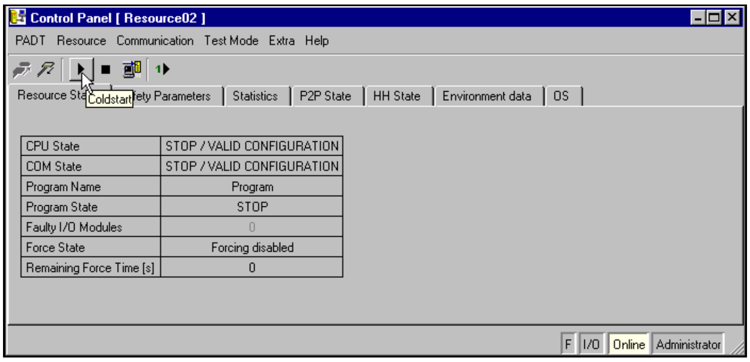


Figure 32: Resource in STOP mode

After the coldstart "CPU State", "COM State" and "Program State" change to RUN.

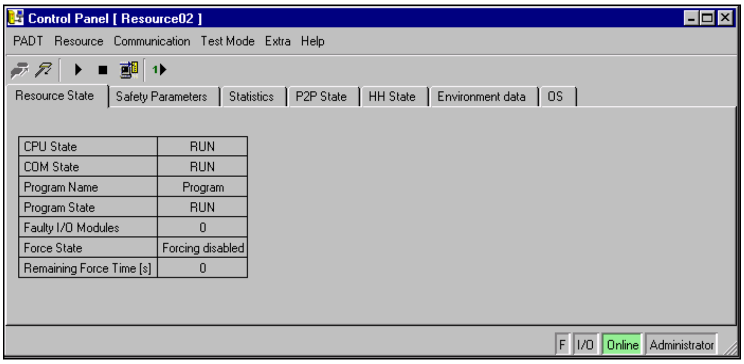


Figure 33: Resource in RUN mode

The Start, Stop and Download functions can also be run from the *Resource* menu.

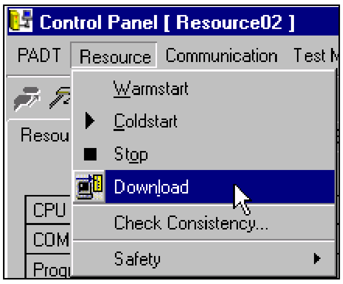


Figure 34: Resource menu

The STOP mode of the CPU is subdivided as follows:

- STOP/LOAD CONFIGURATION
  Remote I/O: A configuration can be loaded into the CPU.
  Control: A configuration with application program can be loaded into the CPU.
- STOP/VALID CONFIGURATION
  Remote I/O: The configuration is correctly loaded into the CPU.
  Control: The configuration (with application program) is correctly loaded into the CPU.
  The CPU can be set to RUN by a command from the programming unit. This starts a loaded application program.
- STOP/INVALID CONFIGURATION
  No configuration present or the loaded configuration is faulty. The CPU cannot be set to RUN when it is in this mode.

When loading a new configuration (with or without application program), all previously loaded data is automatically overwritten.

8.4.4 Loading the Resource Configuration from COM-Flash

In some cases it could be efficient to load the resource configuration from the flash memory of the COM instead of the PADT.

Data errors in the NVRAM and therefore an exceeding of the watchdog time results in the: the situation that there is no access to the Control Panel (CP). In this case the connection parameters must be set from the application program into the controller anew (see chapter 8.4.1). After this the CP is accessible again. Via the option *Extra -> Reboot Resource* the controller can be booted again.

If the controller goes into the state STOP/VALID CONFIGURATION after reboot the application program can be started.

If the controller goes into the state STOP/INVALID CONFIGURATION after reboot the application program must be reloaded in the NVRAM of the CPU again.

With the command *Load Resource Configuration from Flash*, a back-up copy of the last, executable configuration can be read from the COM Flash File System and transferred into the NVRAM. The application program can now be restarted with *Resource -> Coldstart,* without a download of the project being necessary.

For loading the resource configuration switch to ***ELOP II Factory Hardware Management***.

- Select the desired resource and click the right mouse button.
- Via menu *Online -> Control Panel* the window of the Control Panel will open.
- Via menu *Extra -> Load Resource Configuration from Flash* the configuration and the application program can be re-built from the Flash file of the COM module. The data will be transferred from the Flash file to the RAM of the CPU (application program) and the NVRAM of the CPU (configuration).

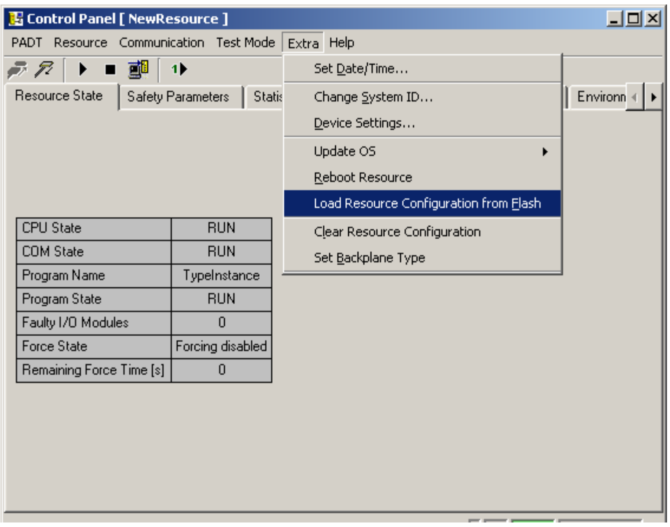


Figure 35: Load resource configuration

8.4.5 Clear Resource Configuration from COM-Flash

Clear Resource Configuration is mainly used to completely remove an application program from the controller. CPU must be in STOP mode.

To clear the resource configuration switch to ***ELOP II Factory Hardware Management***.

- Select the desired resource and click the right mouse button.
- Via menu *Online -> Control Panel* the window of the Control Panel will open.
- Via menu *Extra -> Clear Resource Configuration* the configuration and the application program can be deleted from the Flash file of the COM module.

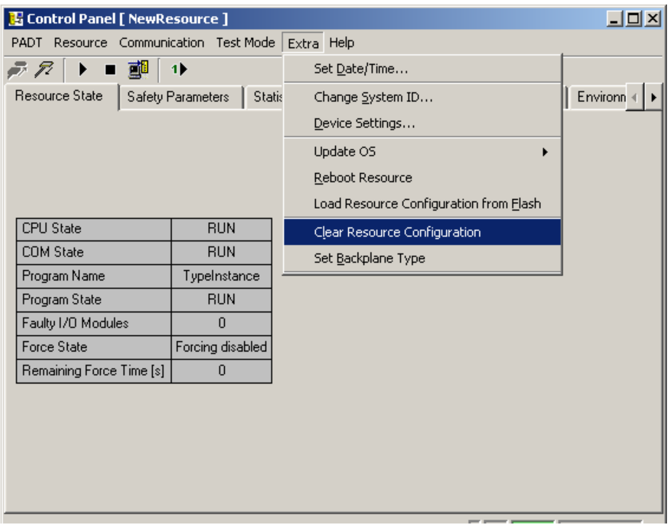


Figure 36: Clear resource configuration

- After setting the command the controller switches to mode STOP/INVALID CONFIGURATION.
- In this mode the application program is not accessible in the volatile RAM of the CPU.
- The configuration (System ID, IP address and user management) is still in the NVRAM of the CPU i.e. a connection to the PADT is still possible.
- The controller can at once be loaded again. The old program in the RAM of the CPU will be overwritten.

Further details about communication between programming unit and PES you will find in the ***ELOP II Factory*** manual "First Steps".

8.4.6 Set Values for Date/Time

If there is no time serving SNTP master within the network (HIMatrix with COM module and correct date/time), the values for date and time have to be set.

With *Set Date/Time* in menu *Extra* of the Control Panel the user can set the clock integrated in the controller. Date and time are especially important for interpretation of long-term and short-term diagnosis (see chapter 10).

Note	Date and time can only be set if the CPU switch *Main enable* is on.

For setting date and time usually the settings of the PADT device are used. If this is not desired the user can make a self-defined input.

The inputs have to be set according to the pre-defined formats.

With *OK* the data will be transferred to the controller and acknowledged with a message in the error-state viewer.

8.5 Operating the Application Program

The programming unit can be used to influence the operation of the program in the controller in the following ways:

8.5.1 Setting the Parameters and CPU Switches

During configuration the parameters and CPU switches are set OFFline. Then they are loaded with the code generated program into the controller. The parameters and CPU switches can also be set in the STOP and RUN modes if the CPU switch *Main enable* is set (see chapter 7.3.2). Only the elements in the NVRAM can be changed. All the others are set during loading.

8.5.2 Starting the Program from STOP/VALID CONFIGURATION

The starting of the program corresponds to the transition of the CPU from STOP/VALID CONFIGURATION to RUN. The program also goes into RUN mode. If the test mode is activated during start-up, the program goes into test mode. In addition to a start in test mode, a cold or warm start is also possible (in accordance to IEC 61131).

Note	The program can only be started if the *Start/Restart allowed* switch is set.

8.5.3 Restarting the Program

If the program is in ERROR STOP, e.g. caused by forbidden accesses to tasks of the operating system, the program can be simply restarted via START button of the control panel. Following the restart, the whole program is checked again.

8.5.4 Stopping the Program

If the application program is stopped, the CPU goes from RUN to STOP/VALID CONFIGURATION.

8.5.5 Test Mode of the Program

The test mode is started via the Control Panel in menu *Test mode -> Enter Test mode* (Hot start) (...Cold start, ...Warm start). With the command *Cycle Step* every time a single step (single logic step) is activated.

Performance of variables and signal values in test mode:

The selection *cold start*, *warm start* or *hot start* determines, which variables values are used for the <u>first step</u> of the test mode.

Cold start: all variables/signals get their initial value.

Warm start: Retain signals keep their values, the others are set to their initial values.

Hot start: all variables/signals keep their actual values.

With the command *Cycle Step* the application program is started in single step mode/test mode. All actual values are retained for the next cycle (frozen state).

Note	The function *Test Mode* is not allowed for the safe operation of the controller!

8.5.6 Online Test

With the function *Online Test* OLT (Online Test) fields could be used within the logic for displaying and for forcing of signals/variables during operation of the controller.

If the switch *Online Test allowed* is switched on then values of signals/ variables could be displayed and forced in the OLT fields. The forced value is only valid until a function in the logic overwrites the value.

If the switch *Online Test allowed* is switched off then values of signals/ variables could only be displayed in OLT fields but not changed.

Further information about using OLT fields you could find under the index "OLT field" in the online help of ***ELOP II Factory Project Management***.

9 Forcing

Forcing describes the intervention of the user in the logic of the application program loaded into the controller. This changes the values of one or more signals. The safety of the controller is also affected.

When using forcing on a controller with safety tasks, always obey the restrictions mentioned in the Safety Manual!

Forcing can only be carried out in the RUN mode or STOP/VALID CONFIGURATION mode. The application program and the inputs/outputs will, however, only be affected when the CPU is in RUN mode.

If a data source is forced, the assigned data sink receives the forced value instead of the process value.

Note	Forcing only takes place in the controller, and not in the programming unit.

Only signals used in the controller can be forced. The physical inputs and outputs cannot be directly forced.

If a signal is forced and this signal is written in the logic the written value will be processed *in the logic* and not the force value! This can influence further signals!

Beyond the logic the force value is always active at forced signals!

Note	The procedure of forcing of signals is described in detail in the ***ELOP II Factory*** manual "First Steps".

9.1 Forcing Allowed

If the *Forcing allowed* switch is set, signals could be forced via online menu *Force Editor*. The switch *Forcing allowed* can be set via the properties of the resource (CPU switch) or online via Control Panel. Online setting is only possible if the CPU *Main enable* switch is set.

The CPU switches can be set via ***ELOP II Factory Hardware Management*** (see chapter 7.3.2):

- Click with the right mouse button on the resource and select sub menu *Properties*. The following window will open:

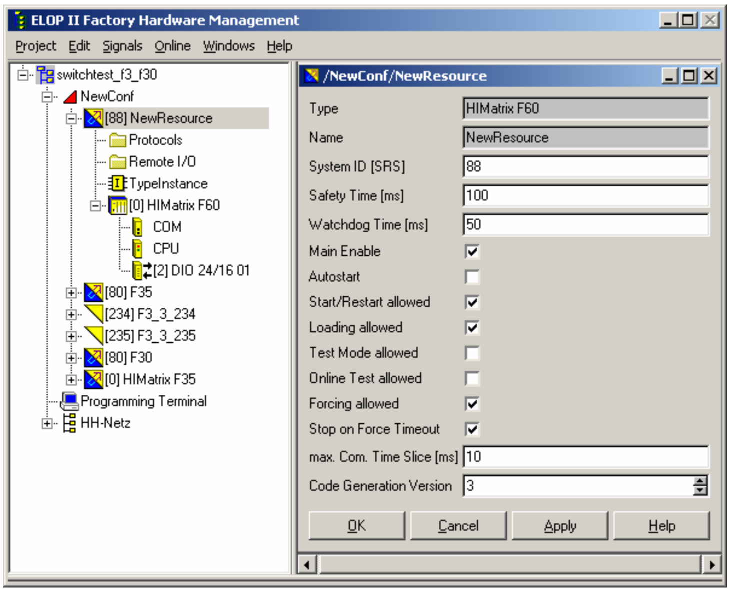


Figure 37: Force switch in CPU system parameters

The *Forcing allowed* switch enables forcing centrally via the CPU to be either permitted or forbidden.

CPU-Switch *Forcing allowed*

- ***Not set:***

  Forcing is not possible.
  Entered force values remain in the system, but have no effect.

- ***Set:***

  Forcing is allowed.
  The entered force values only become effective if the relevant force switch is set for the data source.

9.2 Force Value

The value of a signal in the CPU can be forced via the programming unit. However, the force value must have the same data type as the signal.

The input of a force value is only possible if the *Forcing allowed* switch is set and the logged user has read and write rights.

A force value remains saved in the CPU until

- the application program is stopped,
- the force value is replaced by another value,
- the controller is switched off.

9.3 Force Switch

The forcing switch of a signal can only be set in the Force Editor of the programming unit if *Forcing allowed* is activated. To do this, the CPU must be in RUN or STOP/VALID CONFIGURATION mode. When the force switch is set, the force values have been sent and Forcing is started, the entered force value becomes active. The set switch and the force value are saved in the CPU.

If a new configuration is loaded, all the force switches and the associated force values are reset.

9.4 Force Time

The force time is monitored by the CPU. It is entered in seconds from the programming unit, if *Forcing allowed* is activated.

The value can be entered in the range between 1 second and (2^{28} - 1) seconds. For forcing without time limit, the value -1 must be entered.

Forcing without time limit must only be set after consulting the approval authority for the plant.

To enter the force time, the CPU must be in RUN or STOP/VALID CONFIGURATION mode. The time remains in the CPU until a new configuration is loaded.

If Forcing is already active, a change in time takes place instantly for the actual Forcing.

The force time begins when the force process starts. The time is reset to 0 if a new configuration is loaded or if the operating voltage is disconnected.

The reaction of the controller to the end of a force time (Force Timeout) can be entered via the *Stop on Force Timeout* CPU switch (see Figure 37: Force switch in CPU system parameters).

CPU switch *Stop on Force Timeout*

- ***Not set:***

  The force switch is reset by the CPU (standard setting). The force value is replaced by the process value.

  The force values are only deactivated. With a new start of Forcing the force values will replace the process values again.

- ***Set:***

  STOP of the whole controller after expiration of the force time.

10 Diagnosis

The display for **Diagnosis** can be opened by selecting the corresponding resource in ***ELOP II Factory Hardware Management***:

- Select the resource and click on the right mouse button.
- In the menu select *Online* and in the sub menu *Diagnosis.*
- Via a login window you have to register as user if you haven't done so already.
- The following window will be opened:

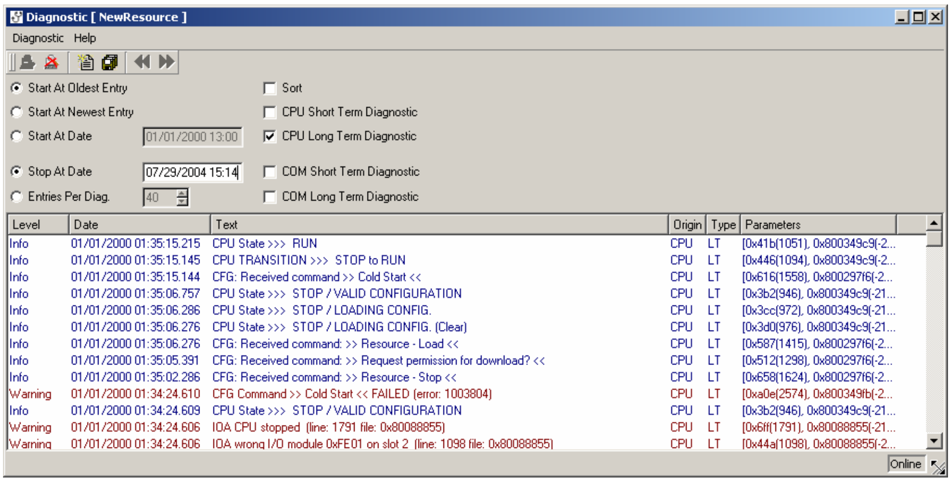


Figure 38: Diagnosis Window

With a running controller messages will appear about the states of the CPU, COM and the I/O modules correlated to defined, adjustable space of times.

The various states of the CPU and COM are collated and stored in a non-volatile memory. For both CPU and COM, a differentiation is made between long-term and short-term diagnosis:

	CPU	**COM**
Entries in the long-term diagnosis	1000	200/250*
Entries in the short-term diagnosis	500	700/800*

* version 4 or newer for COM operating system

The long-term diagnosis of the CPU contains the following operations:

- Reboot,
- Change of operating mode
  (INIT, START, STOP, ERROR STOP),
- Change of program operating mode
  (START, STOP, ERROR STOP, TEST MODE),
- Loading/deleting a configuration,
- Setting/resetting the CPU and program switches,
- Fault in the CPU,
- Loading an operating system,
- Forcing (setting/resetting the *Forcing allowed* switch),
- Diagnosis of the I/O modules,
- Diagnosis of the voltage supply and the temperature.

The long-term diagnosis of the COM contains the following operations:

- Reboot of the COM,
- Change of operating mode of the COM (INIT, START, STOP, ERROR STOP),
- Log in of users,
- Loading an operating system.

If the long-term diagnosis memory is full, data more than three days old is deleted and new entries can be accepted. If all the data is less than three days old, no new data can be saved; it is lost. An entry in the long-term diagnosis indicates that the data could not be saved.

The short-term diagnosis of the CPU contains the following events:

- CPU diagnosis (setting the force switch and force values),
- Diagnosis of the application program (cyclic operation),
- Diagnosis of the communication,
- Diagnosis of the voltage supply and the temperature,
- Diagnosis of the I/O modules.

The short-term diagnosis of the COM contains the following operations:

- HH protocol related events,
- Start /stop during writing of COM file system,
- Failures that occur during loading of a resource configuration out of the file system,
- Divergent time synchronization between COM and CPU.

Errors in parameterization of inputs/outputs may not be recognized during code generation. In the message window of the "Diagnosis" you will receive the message INVALID CONFIG in case of a parameterization error with further information about error codes and source of error. This will help you to analyze errors in parameterization of inputs/outputs.

If the short-term diagnosis memory is full, the oldest entries are removed to create space for new ones. The deletion of old entries is not noted in any way.

The recording of diagnosis data is not safety-related. The data (recorded in chronological sequence) can be read out for analysis via the programming unit (saving the data via disk symbol in diagnosis window); it is not deleted in the controller.

11 F60 Technical Data

F60 housing	
Voltage supply Power supply module	24 VDC, -15 %...+20 %, $r_{PP} \leq$ 15 %, externally fused with 32 A
Backup battery	in the power supply module PS01, part no. 44.000 0019 in the CPU module CPU 01, goldcap (only buffering of date/time)
Operating temperature	0 °C to +60 °C
Storage temperature	-40 °C to +85 °C
Protection	IP 20 (free slots covered with plates, covering plates: part no. 60.528 2106)
Dimensions	260 mm x 312 mm x 245 mm (W x H x D)
Weight	Max. approx. 10 kg (fully assembled with mod- ules)

Table 17: F60 technical data

The technical data of the modules are contained in the relevant data sheet.

12 Operating Conditions

The devices were developed in compliance with the requirements of the following standards for EMC, climate and environment:

IEC/EN 61131-2	Programmable Controllers, Part 2 Equipment Requirement and Tests
IEC/EN 61000-6-2	EMC Generic Standards, Part 6-2 Immunity for Industrial Environments
IEC/EN 61000-6-4	EMC Generic Emission Standard Industrial Environment

For the use of the safety-related HIMatrix controller systems the following common conditions have to be met:

Protection class	Protection class II according to IEC/EN 61131-2
Pollution	Pollution degree II
Altitude	< 2000 m
Enclosure	Standard: IP 20 If requested by the relevant application standards (e.g. EN 60204, EN 954-1), the device must be installed in a required enclosure (e.g. IP 54).

12.1 Climatic Conditions

The most important tests and limit values for climatic conditions are listed in the following table:

IEC/EN 61131-2 Chapter 6.3.4	**Climatic Tests**
	Temperature, ambient: 0...60 °C (Test limits -10...+70 °C)
	Storage Temperature: -40...85 °C (with battery only -30 °C)
6.3.4.2	Dry heat and cold withstand test: 70 °C / -25 °C, 96 h, EUT power supply unconnected
6.3.4.3	Change of temperature, withstand and immunity test: -25 °C / 70 °C and 0 °C / 55 °C, EUT power supply unconnected
6.3.4.4	Cyclic damp heat withstand test: 25 °C / 55 °C, 95 % relative humidity, EUT power supply unconnected

12.2 Mechanical Conditions

The most important tests and limit values for mechanical conditions are listed in the following table:

IEC/EN 61131-2 Chapter 6.3.5	**Mechanical Tests**
	Vibration test, operating: 5...9 Hz / 3.5 mm 9...150 Hz / 1 g
6.3.5.1	Immunity vibration test: 10...150 Hz, 1 g, EUT operating, 10 cycles per axis
6.3.5.2	Immunity shock test: 15 g, 11 ms, EUT operating, 2 cycles per axis

12.3 EMC Conditions

The most important tests and limit values for EMC conditions are listed in the following tables:

IEC/EN 61131-2 Chapter 6.3.6.2	**Noise Immunity Tests**
6.3.6.2.1 IEC/EN 61000-4-2	ESD test: 4 kV contact / 8 kV air discharge
6.3.6.2.2 IEC/EN 61000-4-3	RFI test (10 V/m): 26 MHz...1 GHz, 80 % AM
6.3.6.2.3 IEC/EN 61000-4-4	Burst test: 2 kV power supply / 1 kV signal lines
6.3.6.2.4 IEC/EN 61000-4-12	Damped oscillatory wave immunity test: 1 kV

IEC/EN 61000-6-2	**Noise Immunity Tests**
IEC/EN 61000-4-6	Radio frequency common mode: 10 V, 150 kHz...80 MHz, AM
IEC/EN 61000-4-3	900 MHz pulses
IEC/EN 61000-4-5	Surge: 1 kV, 0.5 kV

IEC/EN 61000-6-4	**Noise Emission Tests**
EN 50011 Class A	Emission test: radiated, conducted

12.4 Voltage Supply

The most important tests and limit values for the voltage supply of the equipment are listed in the following table:

IEC/EN 61131-2 Chapter 6.3.7	Verification of DC Power Supply Characteristics
	The power supply must meet alternatively the following standards: IEC/EN 61131-2 or SELV (Safety Extra Low Voltage) or PELV (Protective Extra Low Voltage)
	The fusing of the HIMatrix devices must be in accordance to the statements of this manual
6.3.7.1.1	Voltage range test: 24 VDC, -20 %...+25 % (19.2 V...30.0 V)
6.3.7.2.1	Momentary interruption immunity test: DC, PS 2: 10 ms
6.3.7.4.1	Reversal of DC power supply polarity test: application note in the power supply data sheet
6.3.7.5.1	Backup duration withstand test: Test B, 1000 h, Lithium battery is used for backup

13 Data Sheets of the F60 Modules

The overview below lists all the data sheets with descriptions of the modules for the F60 controller.

Overview

Data sheet	Functions on the module
AI 8 01	8 analog inputs
AO 8 01	8 analog outputs
CPU 01	Central module with safe**ethernet** /Ethernet and field bus communication
CIO 2/4 01	2 counters, 4 digital outputs
DI 24 01	24 digital inputs (110 VDC)
DI 32 01	32 digital inputs
DIO 24/16 01	24 digital inputs, 16 digital outputs
DO 8 01	8 relay contact outputs (NO contacts up to 230 VAC /110 VDC)
MI 24 01	24 inputs, alternatively analog or digital
PS 01	Power supply module

HIMA
...the safe decision.

HIMA Paul Hildebrandt GmbH + Co KG
Industrial Automation
Postfach 1261 • D - 68777 Bruehl
Phone: (+49) 6202 709-0 • Fax: (+49) 6202 709-107
E-mail: info@hima.com • Internet: www.hima.com

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